INTRODUCTION

1. The Working Party on the Monitoring of Foodstuffs for Heavy Metals was set up in 1971 and has since conducted and published results of surveys of foods for the presence of mercury, lead, cadmium, arsenic, copper and zinc. The results of these surveys were submitted for comment to the Food Additives and Contaminants Committee and the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment.*

2. In announcing the publication of the First Supplementary Report "Survey of Lead in Food"[1] the Minister of Agriculture, Fisheries and Food accepted the conclusions and recommendations of the above Committees

- (i) that the present intake of lead from food in the United Kingdom was unlikely to constitute a hazard to the health of the general population;
- (ii) that further monitoring be continued on the lead content of foodstuffs;
- (iii) that monitoring of canned foods, in particular, should be continued and that can manufacturers should intensify their efforts to discover and eliminate sources of lead contamination.
- (iv) that information is needed on the lead intake from food in children of different ages and other individuals whose diet may contain a higher than normal lead content.

3. In view of the recent publication of the Lawther Committee Report 'Lead and Health'[2] it seemed timely to review the data received so far since publication of the First Supplementary Report in 1975. The analytical data have in most instances been supplied by Government laboratories and Public Analysts.

4. Details of the background to the monitoring, its objectives and organisation may be found in the Second Report of the Working Party[3]. In addition to the monitoring of Total Diet samples and individual foodstuffs, consideration was given to areas of potential lead contamination arising from:

- (i) plumbiferous soils
- (ii) fallout from metal smelting or refining plants on crops

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* Formerly the Toxicity Sub-Committee of the Committee on Medical Aspects of Chemicals in Food and the Environment.

(iii) spreading of sewage sludge on land for agricultural or disposal purposes

(iv) fallout from vehicle emissions on food, crops or on grass in close proximity to busy roads

(v) plumbosolvent water supplies.

Current legislation

5. The Lead in Food Regulations 1961[4] laid down a general limit of 2 mg/kg in food, with other limits for certain specified foods. These Regulations were reviewed by the Food Additives and Contaminants Committee (FACC) who recommended in their Report of December 1975 that the general limit of 2 mg/kg lead in food should be reduced to 1 mg/kg. Changes in the permitted limits for other specified foods were also proposed. New regulations[5] based on the FACC's Report and representations made subsequent to the Report came into operation on 12 April 1980.

Review of Metals in Canned Foods

6. A Review of Metals in Canned Foods including lead is currently being carried out by the Food Additives and Contaminants Committee. A press release[6] issued in March 1981 as a result of this work, warned against the practice of keeping food in opened cans. Most cans are made from tinplate and are soldered with lead based solder at the side seam. There is ample evidence to show that the presence of oxygen accelerates the dissolution of tin from tinplate and of lead from solder[7,8]. Storage of foods in opened cans is therefore likely to lead to increased concentrations of these metals in dissolved form. (This does not apply to foods sold in cans with resealable lids).

Analytical methods

7. For some Government laboratories, lead was determined by atomic absorption spectrophotometry after acid digestion, followed by chelation and solvent extraction of the chelate. Limits of determination obtained using this method varied from 0.01 to 0.05 mg kg^{-1} fresh weight. Other laboratories omitted the chelation and solvent extraction stage which resulted in limits of determination of 0.1-0.2 mg kg^{-1} fresh weight.

RESULTS

8. Results of over 3000 analyses of foodstuffs carried out since 1974 are given in Appendix III. The results are expressed as mg/kg wet weight of the edible portion of the sample as received unless otherwise stated.

Dietary intake of lead

9. Table 1 gives the lead concentrations of the samples of food groups obtained since the beginning of 1975 from individual towns in the ongoing

Total Diet Study; 134 diets were examined altogether. From 1975-1981, the Total Diet comprised 9 food groups representing the average diet consumed in the UK. Each group was prepared separately and analysed for lead; the lead intake by the 'average' person was estimated from a knowledge of the concentration of lead in each food group and the weight of the food consumed each day by the 'average' person. Details of the organisation of this study are given elsewhere[9]. The beverages group is diluted prior to analysis by the addition of a tea infusion. To determine the concentration of the metal in the group on the basis of material purchased and consumed this dilution must therefore be allowed for. In the past a multiplication factor of 5 was used to allow for an average of 400 ml added to a 100 g group; in the revised study the 118 g group is made up to 800 g. The calculated concentration can then be multiplied by the daily consumption to provide an estimate of intake for this group.

10. During 1981 the Total Diets were prepared in the usual fashion but, in addition, further Total Diets were prepared using revised methodology. The revised method differs from the previous method[9] in that 15 groups are now used for the purpose of estimating heavy metal intakes. Diets for the new study are prepared centrally at the Long Ashton Research Station. Details of the revised organisation of the Total Diet Study are to be published shortly. Results in Table 1 for 1981 give data from both the revised study and the study used previously.

11. The mean daily intake of lead by the 'average' person has been calculated on a yearly basis and these values are given in Table 1 and Figure 1. The overall mean intake for 1975-81 was 0.1 mg/person/day or 0.7 mg/person/week. The data in Figure 1 exclude those obtained from the new (revised) 1981 study since the two sets of results are not strictly comparable.

12. It is quite common for the concentration of lead in a food group of the Total Diet to be less than the limit of determination (l.o.d.); historically in these instances for the calculation of dietary intakes it is assumed that the concentration is equal to the limit of determination. Total Dietary intakes of lead calculated using this assumption will tend to be overestimates. For instance, Table 1 shows that for 1981 (not the revised study) the mean daily intake is 0.08 mg. If it is assumed that lead concentrations less than the limit of determination are equal to zero, then the mean daily intake for 1981 becomes 0.06 mg. Thus, true estimates of the Total Dietary intake of lead will lie somewhere between 0.06 and 0.08 mg/day. The effect of this alternative method of calculation for the other years reported is shown below.

Average (mean) daily intake of lead (mg)

	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1981** (revised study)
Assuming values less than l.o.d. = that value	0.12	0.11	0.10	0.11	0.09	0.12	0.08	0.08
Assuming values less than l.o.d. = zero	0.09	0.07	0.08	0.09	0.07	0.11	0.06	0.04

13. These results show the mean of the intakes calculated from each whole diet collected during the year. It is found that the average (median) daily lead intake for each year is approximately 15% (0-36%) less than the corresponding arithmetic mean value. The meat group in one of the 1980 Total Diets contained an abnormally high concentration of lead; there was no specific reason for this. The data for this diet have been included in Table 1, Figure 1 and in the summary table above. Exclusion of the data from this diet reduces the mean intake figures for 1980 to 0.10 mg/day (less than l.o.d. = that value) and 0.08 mg/day (less than l.o.d. = zero). The figures for 1981 show that for the upper bound, results from the revised study 1981 (0.08 mg/day) agree well with the results obtained from the preceding study (0.08 mg/day). Results from the revised study for the lower bound (0.04 mg/day) appear to be rather lower than those from the preceding study (0.06 mg/day). This may be due to the fact that a greater proportion of food groups in the revised Total Diet Study contain lead at less than the l.o.d. than in the preceding study, and to the fact that the diets are prepared in a rural area using deionised water. The MAFF Food Science Laboratory analysed eight 1981 Total Diets (revised study) for lead. The diets were not analysed group by group as is usual but all the food groups were combined and sub-samples of the whole homogenised diets analysed. The analysis of the eight diets give a mean lead intake of 0.04 mg which is in good agreement with the lower bound of intake calculated using the data from the Laboratory of the Government Chemist for the 1981 revised Total Diet Study. This indicates that by assuming results reported as less than the l.o.d. to be zero a more accurate guide to the true lead content of the Total Diet is obtained.

14. It must be emphasised that intakes from the Total Diet Study represent those from a single day's consumption of the National average diet. This study does not take account of differences in lead intake arising from large variations in type and quantity of foods consumed by individuals. Nevertheless such data are available from the results of duplicate diet studies given later in this report.

15. Table 1 shows that lead is relatively evenly distributed among the various groups with the exception of milk and beverages which generally contain lower concentrations of lead than the other groups in the Total Diet. In particular, none of the root vegetables or green (other) vegetables groups analysed contained lead in excess of 1 mg/kg and the average lead concentrations in these groups for each year was always less than 0.2 mg/kg. In addition, it should be borne in mind that the vegetable Total Diet groups before the study was revised contained canned food which would be expected to enhance their lead content. These results indicate that, despite the high concentrations of lead in fresh vegetables which are sometimes found, the lead concentration in vegetables prepared for consumption is relatively low. This phenomenon is even more clearly demonstrated by the results from the Shipham study which are presented at paragraph 29.

INDIVIDUAL FOODSTUFFS

16. Table 2 gives the lead content of individual food items and presents analyses carried out by Government laboratories. Public Analysts have

submitted extensive data on lead in food which were produced as a result of routine duties in connection with the enforcement of the Food and Drugs Act and as a result of special surveys. These data are presented in Appendix V to this Report. The results obtained by Public Analysts tend to be higher than those obtained in Government laboratories. There are several reasons why this should be so. Samples submitted to Public Analysts are not selected randomly since sampling officers pay particular attention to foods which are more likely to be unsatisfactory, eg old stocks and products about which there have been complaints. Moreover if a sample is found to be unsatisfactory it is usual to take further samples from the same source. These factors inevitably raise the value of average and extreme lead concentrations. For the purpose of ensuring compliance with the Lead in Food Regulations the limit of determination does not need to be as low as is required for the determination of absolute levels of lead in food. Consequently analytical methods used by Public Analysts for enforcement purposes (though not for special surveys) may have higher limits of determination than the methods used in Government laboratories.

17. As expected from previous surveys, the data in Table 2 show that the highest mean concentrations of lead occur in concentrated products and in canned foods (Table 2). Thus all foods showed mean values of < 0.1 mg/kg lead with the exception of edible gelatine, wheat gluten, chutneys, tea dust, coffee beans and granules, canned fruit juices and a number of canned fruit, vegetables and fish. Statutory limits were exceeded by only one sample of canned anchovies, two samples of canned fruit juice, one sample of tea dust and one sample of instant coffee granules.

Infant Foods

18. The mean lead values found for canned baby foods were similar to those found for baby foods in jars. This confirms previous findings of an improvement in concentration since the introduction in January 1973[10] of new legislation designed to reduce the amount of lead in canned baby foods. The mean lead concentrations for evaporated and condensed milk samples was < 0.1 mg/kg with a range of <0.05 to 0.25 mg/kg. These products may be used for feeding infants but are usually diluted 2 or 3 times with water before consumption. Therefore the concentration of lead in the prepared feed is, on average, less than 0.05 mg/kg.

Canned foods

19. Results for canned foods showed that, as previously, anthocyanin pigmented fruits, such as blackcurrants, and tomatoes contained higher quantities of lead than other products. For canned fruit juices, mean lead concentrations were significantly higher for lacquered cans, (1.16 mg/kg) than for plain cans (0.09 mg/kg).

20. An estimate of the proportion of lead contributed by canned food to an average Total Diet sample has been carried out recently. Total diets were specially prepared with the usual amounts of the various foods but with different proportions of these foods contained in cans.

The corresponding levels of lead intake were found to be:

Canned Food (% by weight)	**Lead Intake** (mg/week)
0	0.43
4.6	0.48
39	1.6

The normal Total Diet contains 6.2% by weight of canned food.

21. These figures indicate that the process of canning and storage of food makes a substantial contribution to the total dietary intake of lead. Clearly, this figure will vary according to the detailed composition of the diet, the source of the diet and the normal variation of the lead content in all food. The experiments described were special experiments designed solely for the purpose of determining the relative contribution of canned food to the total dietary intake of lead. Because of this, the estimated lead intakes are not strictly comparable with the Total Diet results presented in Table 1.

22. Recent advances in can-making technology have resulted in the introduction of the two-piece can and the welded can. Lead solder is not used in the fabrication of these cans and foods packaged in them will contain less lead than similar foods packaged in conventional cans soldered with 98% lead/2% tin alloy. Two of the leading UK can manufacturing companies have recently made known their intention to substitute by the mid-1980s two-piece and welded food cans for lead soldered cans. This will inevitably result in a decrease in the exposure of the UK population to lead.

Fish

23. Since the First Supplementary Report on Lead was published[1] the Fisheries Laboratories of the Ministry of Agriculture, Fisheries and Food and of the Department of Agriculture, and Fisheries for Scotland have analysed a considerable number of samples of marine fish.

24. The number of fish analysed is well in excess of 2500 and the samples analysed cover the majority of species and areas around the United Kingdom which are fished commercially. In no case did the concentration of lead found exceed the limit of determination of the methods used (0.1-0.2 mg/kg). More detailed investigations carried out for other purposes[11] strongly suggest that the concentration of lead in the muscle (edible) tissue of marine fish as caught is unlikely to exceed 0.05 mg/kg net weight and may well be considerably lower than that[12].

25. In contrast, as the table below indicates, analyses by the DAFS Freshwater Fisheries Laboratory suggest that freshwater fish contain rather higher concentrations of lead than marine species. A high proportion of the fish analysed from Scottish rivers and lochs contained lead in the range 0.1 to 0.5 mg/kg. Nevertheless with the exception of eels, which may occasionally exceed 1 mg/kg lead in their muscle tissue, freshwater fish usually contain less

than 0.5 mg/kg i.e. up to ten times the concentration likely to be found in marine fish. In view of the very small average per capita intake of freshwater fish the significance of this finding in terms of the diet of the average consumer is minimal.

Fish	**Source**	**Number Analysed**	**Concentration Range** (mg/kg fresh tissue)
Rainbow trout	Fish Farms	41	<0.06-0.27
Brown trout	Lochs, Rivers	57	0.04-0.38
Sea trout	Estuaries	48	<0.13-0.44
Salmon	Rivers	17	All <0.25
Pike	Lochs, Rivers	16	0.15-0.60
Eels	Rivers	7	0.30-1.6

Shellfish

26. The results of the analysis of shellfish for England, Wales and Scotland are shown in Tables 3, 4 and 5. Altogether over 16,000 individual shellfish were sampled. The values of lead in shellfish varied with species and region. In general, mussels showed the highest concentrations of lead, ranging up to a mean value of 3.3 mg/kg. Shrimps, queens and prawns occasionally showed high values but most other shellfish showed mean values of lead less than the limit of determination. In particular, crab and lobster both showed little sign of lead contamination.

AREAS OF POTENTIAL LEAD CONTAMINATION

Plumbiferous soils

27. A number of areas in Great Britain have a high lead content in the soil due to past mining or smelting activities: the North Derbyshire lead ore fields is one such area. Various relevant aspects of lead contamination of the local environment have been investigated by MAFF in the past. During an investigation of lead poisoning in cattle in the area, concentrations of lead in silage were found to be sometimes as high as 300 mg/kg (dry matter). The various techniques of production affected the amount of soil-borne lead incorporated into the silage.

28. About thirty dairy farms in the area were estimated to have high lead concentrations in their soil. Most of the milk from these farms goes to dairies in Sheffield. A statistical analysis of the Total Diet data received since 1975 showed that there was a significantly higher lead concentration in milk from Sheffield than for the rest of the UK, although the actual concentration in the Sheffield milk supply was still very small at 0.02 mg/kg. Concentrations of lead in milk are normally less than or equal to 0.02 mg/kg. Concentrations of lead in two batches of milk sampled in January and May 1979 from cattle grazing in this area on land affected by the operation of lead workings showed mean values of 0.14 and 0.04 mg/kg respectively [showing that concentrations of lead in milk were raised in comparison with control

samples]. Subsequently, action to reduce lead in silage was initiated. Arrangements were made for silage and soil from nine farms to be sampled together with milk from local herds. Results for milk sampled in October 1980 and January 1981 gave mean concentrations of 0.04 and 0.03 mg/kg respectively. This milk is bulked with other milk from uncontaminated areas which is why the Total Diet milk sample from Sheffield does not contain lead at a concentration more than 0.02 mg/kg. This concentration of lead in milk does not give cause for concern.

29. Results of a nation-wide geochemical survey carried out by Imperial College, London revealed exceptionally high concentrations of cadmium in the soil in and around the village of Shipham in Somerset. Soil concentrations of both lead and zinc were also found to be high in this area. Surveys of metals in garden soil and crops and three dietary surveys were carried out in 1979. Two 4-week diary studies were carried out during May and September 1979 and a one-week duplicate diet study in September 1979. Duplicate diets were analysed for cadmium, lead, copper and zinc. The results of crop analyses for lead are shown in Table 6. Concentrations of lead in winter vegetables were considerably higher than those in summer vegetables, possibly due to the accumulation of lead from air and dust during the relatively long winter growing season. Comparison of Table 6 with Table 10 shows that lead in crops from Shipham was noticeably higher than background values, although this was not reflected by the analysis of duplicate diets which showed a weekly mean lead intake of only 0.33 mg (range 0.1-1.0 mg). In order to compare this value with the weekly intake obtained from the Total Diet Study a correction has to be applied for the difference in weight of the diets. The adjusted mean value is 0.46 mg/week (range 0.14-1.4 mg). When allowance is made for the addition of milk and beverages this becomes 0.64 (range 0.32-1.58) mg lead per week which differs very little from the mean weekly lead intakes as obtained from the 1979 Total Diet Study (mean 0.66 mg, range 0.43-1.55 mg). A correlation of lead intake from the duplicate diet with calculated lead intake (obtained from the diary studies) gave a correlation coefficient of about 0.30 and a slope of 0.5, indicating that the actual lead intake was on average only half that which would be expected from the lead values found in crops. This difference was probably due to the effects of washing, preparation and cooking on the lead content of vegetables and fruit.

30. Certain areas of Wales contain soils with higher than normal concentrations of lead due to past mine workings and one such area is Clwyd in North Wales. Soil concentrations measured range from 127 to 2901 mg/kg, a range very similar to that found for soil lead in farms around Shipham. Crops grown on experimental plots in Clwyd showed higher values for lead than those found at Shipham. After allowing for losses of lead in washing, preparation and cooking of vegetables it is unlikely that lead intakes will be elevated much above normal values. A survey of blood lead concentrations carried out in adults living in the Clwyd areas has shown normal concentrations and a survey of blood concentrations in children is currently being organised.

Fall-out from smelters

31. Soil lead concentrations may be higher than normal in the vicinity of disused smelters. Table 7 shows figures for lettuce and beetroot obtained from domestic gardens in an area around a disused smelting works in South Wales. Comparison of the data obtained with those obtained in other urban areas indicates that this area is in no way abnormal. Table 7 also gives figures for milk samples obtained from 40 farms, all lying within about 7 miles of the disused smelting works. Sampling was carried out twice, first when the cows were at pasture and again in the following spring when most of the cows were inside and being fed on conserved fodder (mainly hay) and concentrates. Although the mean value for winter milk was slightly lower than for that produced at grass, individual farms did not show significant differences. The lead concentrations in milk produced in the area were not different from the national average.

32. Monitoring of crops grown near smelters has been carried out and the results for one such region is shown in Figure 2 and Table 8. The smelter concerned produces a very wide range of pure metals, alloys and salts including tin/lead (for solders) lead/antimony (for batteries) and lead/bismuth (for fusible alloys). Figure 2 shows that lead contamination of the outer leaves of Brussels sprouts has shown an overall decrease over the last few years, although there is a very marked seasonal variation. The overall decrease is most likely to be a reflection of the Company's efforts in recent years to reduce emissions into the atmosphere. The concentrations of lead on the inner leaves were all below 1 mg/kg. Data for lettuce show that in a number of cases concentrations of lead exceeded 1 mg/kg even on inner leaves but a large proportion of this contamination would be removed on washing. Washing of soft fruit removed between 0 and 60% of the lead present on harvesting. Other studies have shown that the degree of contamination of outer leaves of vegetables decreases markedly with distance from the smelter, indicating that contamination is mainly due to aerial deposition of lead.

Lead uptake in crops from soils treated with sewage sludge

33. Accumulation of lead can occur in soils treated with sewage sludge. Factors such as soil type, pH, organic matter content and plant species determine how much of this lead is taken up by crops. In order to obtain information on the uptake of cadmium and lead by vegetables a survey was undertaken of commercial crops harvested during a 12 month period from market gardens which had previously been treated with sewage sludge for many years. Total soil lead concentrations ranged from 7 to 496 mg/litre.

34. Results for individual crops are shown in Table 9. Highest values for lead were found in herbs and leafy crops such as kale, spinach and broccoli. The lead concentrations of the plants were subjected to a stepwise multiple regression analysis against the lead concentration in the soil, soil pH and organic matter content. There were no significant correlations between plant lead (dry weight) and any one of the above parameters. The mean values of lead for the vegetables grown in this study were equal to or only slightly

greater than the background values reported in Table 10. Less than 3% of the total number sampled contained concentrations of lead greater than 1 mg/kg.

35. A total of 21 individuals who consumed food grown in these market gardens supplied a duplicate diet of all the food they consumed for one week in October 1978. In addition they kept a diary of the individual fresh vegetables which they consumed and were locally grown as well as a record of the weight of vegetables consumed. Subsequently in 1979 a 4 week diary study was carried out on the same population in which participants recorded weights of home-grown vegetables consumed. Intakes of lead were estimated in this case from the known concentrations of lead in the foods consumed and the weights of the food consumed. Estimates of the mean lead intake from both the diary and duplicate diets showed that the intakes of lead by the participants in the study were no greater than the national average estimated from Total Diet Studies. This is not surprising since lead is not readily taken up from the soil by plants and translocation to edible tissues is limited.

36. In trials carried out by the Anglian Water Authority at four different sites with a history of sewage sludge application, lead concentrations were determined in spring barley, winter barley, winter wheat, potatoes, rapeseed, lettuce, cabbage and redbeet. The results showed that for a 25-fold increase in soil lead, there was only a 2-fold increase in lead content of rape, lettuce, cabbage and beetroot. For other crops little effect was observed. Thus, for lead, despite a large difference in soil metal concentrations between the sludged fields, this difference was not reflected in metal uptake of the crops grown on them, a result which confirms those reported in paras 33-34 above. In other trials carried out in 1979, the Ministry analysed lettuce samples grown experimentally by the Anglian Water Authority on land at a sewage works which had received repeated applications of sludge. Lettuce from soil with a total lead concentration of 1230 mg/kg were analysed either as 'point of sale' material or after the outer leaves had been discarded and the inner leaves thoroughly washed. The sample which was contaminated with soil contained 42.5 mg/kg lead on a dry matter basis, while the washed sample contained 14.6 mg/kg (0.73 mg/kg lead on a fresh weight basis). Thus, while translocation of lead from this highly contaminated soil was limited, surface contamination resulted in high lead concentrations in produce which could have been offered for sale.

Lead fall-out from the atmosphere

37. Fall-out of lead occurs because the atmosphere contains lead aerosols from motor exhausts and industrial sources. About 90% of airborne lead is thought to be derived from emissions from petrol engines. This fall-out contributes to the lead in crops by foliar contamination and also by build-up of lead in topsoil. Surveys in the UK and other countries have shown however that the contamination of roadside crops is primarily due to surface contamination rather than to the uptake of lead from the soil[13,14]. The extent of contamination of roadside crops depends on the following factors: a) distance from the road b) traffic density c) duration of exposure d) plant species e) climatic factors eg wind direction. A study near the M4 motorway

carried out by Harwell showed that the zone affected extended to only about 30-50 metres from the motorway[15].

38. In general, highest lead concentrations are found in leafy vegetables, for example lettuce, but about 50% of the deposited lead is removed on washing and by removal of the outer leaves. Generally, lead concentrations less than 1 mg/kg are found in soft fruit grown near the roadside [16,17] although levels higher than 1 mg/kg have been found in elderberries[14]. Of the cereal crops examined barley shows the highest concentrations. In both edible root crops and tree fruit most of the lead is concentrated on the skin. Again, a considerable proportion of lead is removed by washing and peeling. Grass grown very near to major roads can sometimes retain lead at concentrations undesirable for animal feed. Animals, however, are very rarely fed exclusively on herbage grown very close to main roads.

39. While increased atmospheric fall-out of lead from vehicles or industrial sources in a crop growing area will contaminate only a relatively small part of the diet of a large number of individuals there are instances where 'lead fall-out' may have a greater effect albeit on the diets of a smaller number of individuals. The results of analyses of the 1980 Total Diet samples indicated that all the food groups from one college contained slightly more lead than was usual. Lead intakes calculated from the results for the previous 6 diets produced by the college between 1977 and 1979 averaged 100 µg/day (range 70-140 µg/day) while the intakes calculated for the two diets prepared in 1980 were 170 and 180 µg/day. Since the increase in lead concentration was reasonably uniform across all the food groups in both of the diets, it seemed likely that the contamination was associated with the preparation of the food and not the food per se. Although all aspects of the sample preparation have remained unchanged from 1977-1980, the 1980 diets were prepared during a time of extensive building alterations and considerable accumulation of dust was evident in the domestic science department. This dust derived from old building materials, was very probably the source of a slight lead contamination of each dietary group, resulting in about a 75% increase in calculated lead intake from these diets. The plumbing in the building was not affected by these alterations. Although this finding was made with an experimental diet, there is no reason to suppose that the same would not be true for diets prepared in the home. The lead intake calculated from the diet prepared in 1981, at 85 µg/day, has reverted to within the previous range.

40. Investigations are currently being carried out to determine the contribution of atmospheric lead to lead concentrations found in various crops. An independent estimate of the contribution of fall-out lead to dietary lead intake has also been made by measurement of ^{210}Pb in the diet. ^{210}Pb is an isotope formed naturally in the atmosphere by decay of radon and is deposited partly in rain and partly by dry deposition. It has a half-life of 20 years. If it is assumed that ^{210}Pb deposited from the atmosphere enters into food in exactly the same way as stable lead from the atmosphere then the contribution from atmospheric lead to the dietary intake of lead may be calculated from the following equation:-

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$$\text{Dietary lead from fall-out} = \frac{\text{Fall-out of lead} \times {}^{210}\text{Pb in the diet}}{\text{Fall-out of } {}^{210}\text{Pb}}$$

41. The average amount of ^{210}Pb found in eight total diets was 1.28 pCi (range 1.09-1.60 pCi). In the UK the fall-out of stable lead is about 20 mg m^{-2} yr^{-1} and of ^{210}Pb is about 2.0 nCim^{-2} y^{-1} depending upon rainfall. Inserting these figures into the equation yields a figure of about 13 µg/day for the amount of dietary lead contributed from atmospheric fall-out. This figure is almost certainly an overestimate because some of the food consumed in the UK is imported from countries where the fall-out of stable lead is lower than in the UK. For example a proportion of the cereals imported into the UK comes from North America where, in the main food producing areas, the fall-out of stable lead is generally less than 10 mg m^{-2} yr^{-1}. From the Total Diet data summarised at paragraph 12, the mean lower and upper bounds of lead intake are 0.08 and 0.10 mg/day (80 and 100 µg/day) respectively. This excludes the 1981 (revised) data which are not strictly comparable. Thus the average proportion of dietary lead derived from atmospheric fall-out is likely to be no more than about 13% to 16%. It should be emphasised that the reliability of this estimate is dependent on the validity of the assumptions used in its estimation.

42. In 1981 the Government announced its intention to reduce by 1986 the maximum lead content of petrol sold in the UK from 0.4 to 0.15 g/litre. The Working Party intends to monitor the effects of this action on the lead content of food.

Lead from plumbosolvent water supplies

43. Plumbosolvent water tends to dissolve any lead present in water tanks and pipes. Residents of households containing lead pipes situated in areas with soft water supplies may be liable to higher than normal values of dietary lead intake. In particular, infants who are bottle-fed consume a large part of their diet as water since reconstituted feed contains as much as 90% water.

44. An investigation has been carried out in Glasgow, a soft water area, on about 130 infants, approximately 80% of whom were totally or partially bottle-fed. The objective of the study was to determine the relationship between water lead, dietary lead and blood lead in infants. The dietary lead was estimated by means of the duplicate diet technique in which mothers supplied a duplicate of the liquids and/or solids consumed by the infant over one week. This was weighed and then analysed for lead. The results showed that there was a positive association between lead intake and blood lead concentration and that this relationship was probably curvilinear. Thus, successive equal increments of lead intake have progressively less effect on the increments in blood lead concentration. Actual intakes ranged up to just over 3 mg lead per week. Further, the results of the study showed that the use of water from the hot tap may lead to greatly increased exposure to lead and should therefore be avoided for food preparation.

45. Subsequent to the completion of this study, in April 1980, the pH of the supply water was increased to about 9 by lime dosing. Indications are that this action has reduced the plumbosolvency of the water in the majority of Glasgow dwellings thereby decreasing exposure to lead from the diet.

46. Cooking water can be a significant source of dietary lead intake in areas where the lead concentrations in water are higher than average. It is thought that the lead from the cooking water adsorbs onto the food being cooked.

47. Experiments have shown that the uptakes of lead from cooking water were highest for leafy vegetables such as cabbage, but were also high for cauliflower, carrots, spaghetti and rice. Uptakes were low for peas, potatoes, parsnips, apples and pears. Uptake was greater from soft than hard water for all these foods except rice[18]. An equilibrium concentration was reached very rapidly for cabbage and spaghetti after cooking for only five minutes. The uptake of lead by cabbage from water appears to be linear up to a water lead nitrate concentration of 20 mg/litre when the lead concentration in cabbage reaches 13 mg/kg. Calculations of the contribution made by lead in water used for the preparation of foods and beverages to the total dietary lead intake indicates that at average concentrations of lead in water of 0.02 mg litre^{-1}, the contribution is about 10% but this can rise to about 40% as lead concentrations in the water approach 0.1 mg litre^{-1} [19].

Contribution to Lead Intake from Air, Water and Food

48. Lead intake from air, water and the diet, including ingested dust, determines total lead intake. In addition, lead in the diet is influenced by lead in water and air. In the following table two extreme cases are described; a person living in a rural dwelling with no lead pipes or water tanks and a person living in an urban dwelling with lead plumbing and a plumbosolvent water supply.

	Air			Water			Diet
	Concentration (μg/m³)	**Vol inhaled** (m³)	**Daily intake** (μg)	**Concentration** (μg/litre)	**Vol consumed** (litres)	**Daily intake** (μg)	(including contribution from cooking water) (μg/day)[a]
A. **Rural area** (low)	0.1	15	1.5	5	1.1	5.5	94
B. **Urban area** (very high)	2[b]	15	30	100	1.1	110	140

a. See Reference 19

b. Suggested EEC limit for lead in air

49. The contribution from air and water intake can therefore vary from about 7μg to at least 140 μg per day depending on the levels of lead in water and air. The influence of lead in air on lead in the diet has been excluded, but the influence of lead in water on lead in the diet has been included. It should be emphasised that this Table does not represent the amount of lead absorbed by the body, but only the amount taken in.

Historical Aspects

50. Historically, concentrations of lead in foods and beverages have decreased markedly over the past 40-50 years. A review of these changes is given in Annex 1 to this Report. The decrease in lead concentrations has largely been due to the co-operation between Government and industry coupled with improvements in technology.

APPRAISAL OF RESULTS

51. Continuing surveillance of the UK average diet using the Total Diet Study has established that the intake of lead from foodstuffs in the general population is not increasing. Mean lead intakes ranged from 0.08 mg/day (1981) to 0.12 mg/day (1980), (Figure 1). These compare with a value of 0.14 mg/day from food alone from the previous Report[1].

52. The Joint FAO/WHO Expert Committee on Food Additives in its 16th Report[20] established a provisional tolerable weekly intake of 3 milligrams of lead per adult. The average person in the United Kingdom is estimated to consume 0.7 mg per week from food and beverages. It should be borne in mind that this intake is likely to be an overestimate since it was calculated by assuming that lead concentrations less than the limit of detection are equal to that value.

53. Monitoring of individual foodstuffs has continued to provide more information on lead content. Very few examples were found of foods or beverages which exceeded the new statutory levels. Highest values were found for concentrated foods and canned food products.

54. As found from the previous Reports, excess lead is not found in fish. Shellfish contained higher concentrations of lead than fish, and mussels, in general, showed the highest concentrations of lead.

55. Crops grown in areas with a higher than average soil lead concentration may contain higher lead concentrations than crops in general. However, the effect is very small. Much of the lead is removed by washing and preparation, and duplicate diet surveys of people living in such areas have shown that intakes are not elevated above normal. Cattle grazing in such areas have, in one instance, shown a slight increase of lead concentration in their milk but this was found to be due not only to soil lead contamination of silage but also to the grazing of contaminated herbage.

56. Dietary lead intakes are likely to be higher than normal in areas with plumbosolvent water because the water is consumed in beverages and is used for cooking. In particular, bottle-fed infants, for whom water represents a large proportion of the diet were found to have particularly high lead intakes. Duplicate diet results from one survey have shown that in some cases the lead intake of infants has exceeded 3 mg per week lead. As water lead concentrations increase, the contribution of lead in water in beverages and

cooked foods increases so that at a lead concentration in water of 0.1 mg/litre the average lead intake from food has almost doubled and the contribution to the total (elevated) intake from lead in water is about 40%.

CONCLUSIONS

57. (i) The intake of lead from 1.46 kilograms of food and beverages consumed daily by the average person in the United Kingdom is estimated to be approximately 0.1 mg (0.7 mg per week). In areas of plumbosolvency the intake will be elevated due to the higher intake via beverages and cooked foods (Paragraphs 12 and 56).

(ii) Continued monitoring of individual staple foodstuffs has given results similar to those of the previous Report[1] and lead concentrations are generally low. All but a few samples were below the levels prescribed in the Lead in Food Regulations, 1979 (Paragraphs 17 and 53).

(iii) The mean lead concentration for infant foods in cans in current manufacture was 0.07 mg/kg compared with the mean concentration of 0.24 mg/kg given in the Second Report (1972)[3] and 0.07 mg/kg given in the First Supplementary Report (1975)[1]. This is similar to the concentration of 0.05 mg/kg found for infant foods in jars (Paragraph 18).

(iv)Bottle-fed infants living in areas supplied by plumbosolvent water are liable to increased intakes of lead which can in extreme cases exceed 3 mg/week. It is probable that successive increases in lead intake have progressively less effect on increments in blood lead concentration (Paragraphs 44 and 56). Nevertheless many of the observed blood lead values in such areas exceeded the action level set in EEC Directive 77/312[21]. Measures in the UK to reduce exposure to lead from water are in progress and where the results of this action have been investigated a decrease in blood lead concentrations has been found.

(v)Shellfish contained higher concentrations of lead than did fish with mussels showing the highest values. However, when considered in relation to the low mean daily consumption of shellfish, the intake of lead from this source is likely to be low (Paragraphs 26 and 54).

(vi)Crops grown in areas of high soil lead content, in areas of atmospheric contamination or where sewage sludge is spread on the land may contain higher concentrations of lead than crops in general. There is a clear need to obtain more information on the uptake of lead into crops. The discarding of outer leaves, washing and cooking normally reduces lead concentrations considerably. Local dietary intakes have shown that intakes are not elevated above normal either at Shipham or in an area where high rates of sewage sludge have been applied in the past (Paragraphs 29 -36 and 55). The Working Party recommends that further work is carried out on the effect of washing, preparation and cooking on the lead content of the diet.

(vii)Total lead intake is influenced by lead in air, water and the diet, (Paragraphs 48, 49). The Working Party recommends that more work be initiated to assess the relative absorption of lead from each of these three sources.

COMPARISON OF CONTEMPORARY AND HISTORICAL DATA

For many years Government has been making efforts to reduce the contamination of food by lead. This annex briefly discusses the reductions in the lead concentration of food, expecially canned food which have been achieved over the past 50 years. The Working Party has drawn on the data supplied to the Ministry in the past and the information in this annex shows that the lead concentrations in many individual foods, and the dietary intake of lead have been reduced. For canned foods, for instance, measures taken by industry have led to reduced lead contamination of soft drinks, evaporated milk and corned beef. Similarly, lead plumbing was commonplace in canneries as was the practice of repairing food preparation vessels by soldering. This is not the case today. There have also been improvements in can-making to reduce the incidence of adventitious lead on the inside of cans. In general, therefore, reduction in exposure to lead has been brought about both by improved technology and by measures taken by industry both voluntarily and in response to tighter legislation.

In the following, where data are not available from Government laboratories comparison has been made with Public Analyst data given in Appendix V Since these results are likely to be higher than average (see Paragraph 16) actual differences may be even greater than is shown by these comparisons.

Meat and Fish Canned corned beef is known to be susceptible to contamination by lead due to the method of can construction. The current legislation for lead in foods[5] therefore affords canned corned beef a higher limit than that for foods generally. The present day mean concentration of lead reported in Appendix V is 0.7 mg/kg. In 1944 it was considered very difficult to achieve concentrations less than 2.5 mg/kg and that to manufacture such a product was impossible. In spite of this, data for the 1940s indicate that concentrations lower than 2.5 mg/kg were found. A summary of the data is shown in Table 11 together with data for other canned meats.

The early practice of grilling sardines on lead coated trays has been described in the past[22], and Cheftel and Pigeaud[23] concluded in 1937 that it was impossible to reduce lead concentrations in canned sardines below 3 mg/kg. Again, this is not wholly borne out by the data in Table 11 but these show, after comparison with those in Table 2 that the position has improved greatly in the intervening period. Data for other canned fish also show that the lead concentrations have decreased over the years.

Beverages In the past, contamination of draught beers and ciders by lead from pipes and vessels in public houses was well known[24]. The average lead concentrations in draught beer, shown in Table 11 decrease over the years toward the low concentrations found now. Similarly lead concentrations in ciders have dropped from the average of 0.35 mg/kg found during the 1940s to a value of <0.01 mg/kg in the 1970s. The high concentrations found in the past almost certainly reflect the use of lead pipes in public houses and the use of white lead paint on the ends of cider casks.

The effectiveness of cooperation by industry in remedying instances of food contamination is clearly illustrated by the response of industry to the finding that lead soldered cans were contributing to high metal concentrations in carbonated beverages. Shortly after the statutory limit of 0.2 mg/kg lead in ready-to-drink soft drinks came into force in 1964 (after an initial period of 2 years at 0.4 mg/kg) a survey of 51 samples of canned soft drinks showed that about 50% exceeded the statutory limit. Even before the results of this survey were known the can manufacturers had started the changeover from lead/tin soldered cans to cans soldered with pure tin; the last lead soldered cans were packed only 5 months after the introduction of the lower statutory limit. The results of the analyses of the soft drink samples prompted a recall from depots and wholesale stores of drinks packed in lead soldered cans. The effectiveness of the legislation and the accompanying action is illustrated by the data shown in Table 11 and the recent data in Table 2. Wines also contained higher concentrations of lead in the past than now and this was in part due to the occasional use of lead seals on bottles. In addition it was considered in 1953 that natural lead in vineyard soils resulted in "all wines on sale in Britain, with very few exceptions" containing more than 0.2 mg/kg of lead, and samples with lead concentrations below this were apparently "just isolated examples"[25]. Similarly in 1955 new Bordeaux Wines were said to naturally contain up to 0.5 mg/kg lead.

Tea was, and still is, a commodity that often contains high concentrations of lead. This was exacerbated in the past by the use of lead linings in tea chests, although the results of analysis of samples taken in 1933-36 shown in Table 11 indicated that this effect was not as great as might be supposed. The practice of using lead in tea chests was stopped by the Indian tea industry by 1950 at the latest and the Ceylon Tea Research Institute considered that since 1939 no samples of Ceylon tea would have a lead concentration above 3 mg/kg, and most would be well below 2 mg/kg. These low concentrations were achieved by replacing equipment such as lead coated drier trays and avoiding direct contact with metallic rolling surfaces. As late as 1949 the Government Laboratory stated that concentrations of lead in tea as high as 28 mg/kg were considered typical of teas packed in chests lined with lead. Monier-Williams in 1949[24] stated that 2 mg/kg of lead in tea leaves was unavoidable. Evidence shows, however, that most of the lead associated with tea remains in the tea leaves on brewing and is not, therefore, consumed[26]. Tea leaves have also been shown to absorb lead from water, an effect noted by Smart et al[19] and Moore et al[27].

Vegetables Comparison of the data summarised in Table 2 with those in Table 11 shows that concentrations of lead in canned vegetables are much lower now than in the past. To some extent this effect is accentuated by the better analytical methodology available now and the more precise reporting of the data. Nevertheless this does not account for all of the high concentrations found in the past, and improvements in canning technology must have contributed a large proportion of the apparent improvement.

Another instance of a practice, now discontinued, which contributed to the lead contamination of the food supply was the marking of the outside of potato sacks with a red lead based pigment. Potatoes in open weave sacks had been declared unfit for human consumption as recently as 1962 as a result of this practice. No data are available for the lead content of the potatoes.

Miscellaneous It is recognised that herbs and spices, both in the 'natural' and dried state, accumulate high concentrations of lead. The practice of colouring spices with lead chromate has often been described, but once this practice was discovered in Australia for instance in the 1870s it quickly subsided[28] and although its reappearance in England in 1933 is described by Monier-Williams[24] it was recorded in 1948 that the 'misguided practice' had ceased[29]. The data in Appendix V show that even now the average lead concentration in curry powder is 2.1 mg/kg. During 1942-45, however, 47% of curry powder samples analysed by a London public analyst contained more than 10 mg/kg of lead, but by 1945-49 the proportion in excess of 10 mg/kg had dropped to 25%. Other data from the period are shown in Table 11.

The lead concentrations in foods frequently consumed by young children should be as low as possible. Data on present day concentrations in infant foods and confectionery are shown in Appendix V and although no comparable data from earlier samples are available, some results for canned evaporated milk and ice lollies are presented. A large survey by the Government Chemist showed that 5% of evaporated milk samples analysed between 1935 and 1948 contained lead in excess of 2 mg/kg, with an average figure calculated to be 1.1 mg/kg. The decrease in lead concentrations in such products since then is undoubtedly due to improvements in canning technology. A survey in 1953 of ice lollies bought in the North of England showed that over 20% had lead concentrations above 1.5 mg/kg; the lead was considered to have come from the receptacles in which the 'lollies' were made.

Dietary intake It is difficult to assess the changes in dietary intake of lead that have occurred over the years as the earlier methods of measurement, as well as the analytical techniques were not as precise as they are now. Table 1 shows that the present average dietary intake of lead is about 0.1 mg/day and that it has not changed much in the last few years.

One of the earliest estimates of dietary intake of lead was made by Monier-Williams in 1938[30]; this was based on the analytical data in his report and food consumption data published in 1921[31]. Lead intake from food was calculated to be between 0.2 and 0.25 mg/day, in reasonable agreement with Kehoe's 1933 estimate of 0.16-0.28 mg/day[32]. An unpublished estimate made in 1950 and based on the 1949 National Food Survey data for food consumption and the **maximum** lead content of foods arrived at an estimate of 1 mg/day from 1.5 kg/day of food.

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APPENDIX I

REPORT OF THE COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

SURVEY OF LEAD IN FOOD. SECOND SUPPLEMENTARY REPORT

INTRODUCTION

We were requested by the Steering Group on Food Surveillance to consider the report on the Survey of Lead in Food, Second Supplementary Report, compiled by the Working Party on the Monitoring of Foodstuffs for Heavy Metals (WPMFHM) and to assess hazards to health that could arise from lead in food in the context of present information on the toxicity of lead. We reported previously on Lead in Food in 1975 and on Metals in Canned Food earlier this year.

Our views on the Survey of Lead in Food, Second Supplementary Report, and an assessment of possible health hazards from the quantities of lead in the United Kingdom diet are presented in Section A.

A review of lead pharmacokinetics and toxicology (with special emphasis on subacute and chronic toxicity) is presented in Section B.

SECTION A: LEAD IN FOOD IN THE UNITED KINGDOM
1. EXPOSURE TO LEAD
2. DIETARY LEAD
3. PERMITTED LEVELS OF LEAD IN FOOD
4. SUMMARY AND CONCLUSIONS

SECTION B: TOXICOLOGY OF LEAD
1. ABSORPTION OF LEAD
2. EXCRETION OF LEAD
3. TOXICITY OF LEAD

LEAD IN FOOD

A 1. EXPOSURE TO LEAD

Lead may be absorbed into the body from the gastro-intestinal tract, the lungs and through the skin. For most people who are not occupationally exposed, the diet is the major source of lead. For many people water is of small importance, although for some it has much more influence and can become the major source of lead. The air contributes a varying amount by direct inhalation and may contribute indirectly by contamination of what is ingested. Compounds of lead which are fat soluble may be absorbed through the skin; this is generally the result of occupational exposure.

It would be misleading to discuss an average intake of lead from drinking water. Over 64% of households in Great Britain have less than 10 micrograms per litre (10 μg/1) of lead in tapwater and over 89% have less than 50 μg/1[1]. The remainder exceed this figure, some having more than 300 μg/1. The mean consumption of tapwater is 1.07 litres/day (99th percentile 2.73)[2]. The intake of lead with drinking water may thus vary from the insignificant to an amount exceeding the Provisional Tolerable Weekly Intake (PTWI) for all dietary lead of 3 mg. (Section 2.2). A recently adopted EEC Directive on "The Quality of Water for Human Consumption" will have the effect, by and large, of limiting the lead in drinking water to 50 μg/1 so that an average person might take in about 300-400 μg/week from this source. The general air may contain a wide range of concentrations of lead, but the Government's policy is to limit the level of such lead in future to 2 micrograms per cubic meter (μg/m^3). At concentrations of air lead normally found in urban areas (0.5-1 μg/m^3) it has been calculated that inhaled air may contribute 9-16% of body burden[1]. In addition such lead may contaminate foodstuffs and so be ingested but the significance of this cannot yet be assessed with confidence.

Lead intake can be increased by raised amounts in food, water and air; by intake from adventitious sources, especially paint, and by occupational exposure to lead fumes or dust.

A 2. DIETARY LEAD

2.1 Monitoring Surveys

Information from over 6000 analyses of foodstuffs carried out since 1974 has been collated by the Ministry of Agriculture, Fisheries and Food (MAFF) and published in the 10th Report of the WPMFHM entitled "Survey of Lead in Food: Second Supplementary Report". These data allow an assessment of the current dietary intake of lead in the general population of the United Kingdom.

The assessment was carried out by measurement of the average daily intake of lead using the methodology of the Total Diet Study[3] and the lead content of a wide range of foodstuffs. Data were collected also on the lead content of infant foods, canned foods, fish and shellfish. Further data derive from a duplicate diet study at Shipham, in Somerset, where the soil is contaminated with lead and cadmium; from the analysis of milk and vegetables from farms contaminated by past or present industrial activities, and from studies of the lead uptake from crops grown on soils treated with sewage sludge. Studies are also reported into the effects that the fall-out of atmospheric lead may have on the concentrations of the metal in crops.

We consider that similar surveys should continue as public concern about the health effects of lead continues unabated and for most people the diet is the predominant source. Priority should be given to foodstuffs high in lead; to studies of the availabilities of lead from the various food groups and to assessments of the overall effects on body burden of lead in water and air.

We note that there is relatively little information about the lead intakes of young children and we are unable to give authoritative advice on what might be considered a tolerable intake by them, and we consider that these topics merit early attention.

2.2 Dietary Lead Intake

In the United Kingdom, except for the relatively small number of people who are exposed to high levels of lead in drinking water, food constitutes the major source. In their report MAFF estimate that the mean weekly intake is about 0.7 mg from food and beverages. There is no evidence that the intake has increased over recent years and it is possible that the figure is an overestimate as in reaching it the assumption was made that lead concentrations less than the limit of analytical determination were equal to that value. MAFF report that very few foodstuffs exceed the statutory levels of the Lead in Food Regulations 1979 and that the highest levels are found in concentrated foods and canned products.

The FAO/WHO provisional tolerable weekly intake for dietary lead is 3 mg.

The Total Diet studies indicate that the mean intake of lead for people living in the United Kingdom is below the FAO/WHO provisional tolerable weekly intake and provides a reasonable margin of safety for those whose diet contains unusual foodstuffs or is excessive in amount. We note that other sources of lead, in particular drinking water and to a lesser degree environmental air, have the potential to raise lead intake to undesirable levels and we welcome the Government's stated policy which is to reduce environmental pollution with lead by all practicable means.

2.3 Infant Diets

MAFF report that the evaporated and condensed milk used in infant diets have a mean lead content of 0.1 mg/kg (range <0.05 to 0.25) and that feeds prepared from such milks with lead-free water have a mean lead concentration of less than 0.05 mg/kg. We note that there are few data on human milk with which this level may be compared but that a recent study[4] in Glasgow indicated that a linear relationship between breast milk and mother's blood lead concentrations could be expressed as:

breast milk lead (μg/kg) = 5 + 0.6 mother's blood lead (μg/dl).

If it is assumed that the mean value for a mother's blood lead will not exceed 20 µg/dl, it is seen that artificial feeding will result in a higher lead intake than breast feeding.

The mean lead concentration for infant foods in cans in current manufacture is reported by MAFF to be 0.07 mg/kg; that in jars is 0.05 mg/kg. We note and welcome the reduction that has taken place since 1972 when the lead concentration in canned food for infants was 0.24 mg/kg.

We draw particular attention to the influence that drinking water may have upon the lead intakes of artificially fed infants. For a majority of the population this influence will be small (Section A1) but in some households the increment to dietary lead from drinking water may be considerable and in one study[4] intakes in excess of 3 mg a week were measured. This implies that artificially fed infants may, in extreme circumstances, receive a lead intake greater than that considered tolerable for adults. We are aware that lead levels in drinking water are being significantly reduced in certain areas and because of the demonstrated impact of high concentrations of lead in water on the dietary intake of lead recommend the extension of such activities receives a high priority. Furthermore we recommend that the opportunity be taken to carry out longitudinal studies of the effects of major changes in exposure to lead.

2.4 **Lead in Crops**

Crops may acquire lead from the soil by translocation and by superficial contamination. Vegetation is also subject to contamination by fall-out from the air, and such deposits may gradually increase the concentration of lead in the soil. We note that MAFF have monitored crops grown on soil contaminated with lead from industry and lead incorporated in sewage sludge applied as a fertiliser. The data indicate that although some crops grown in such circumstances may contain more lead than other crops, dietary studies have not indicated that the lead intake by affected groups is raised above the norm. We consider that the relationship between the concentrations of lead in soil and crops is not fully understood and should be examined further, and that the effects of preparation and cooking upon the lead content of food should also receive further attention.

We note that MAFF have initiated work to examine the immediate and longer term overall effects of air lead upon the ingestion of lead by human populations. Such work is needed to correct important deficiencies in the understanding of the effects of environmental lead. We note that the first results indicate that 16% of dietary lead may be derived from the air but reserve judgement on this finding until further results are available.

A 3. PERMITTED LEVELS OF LEAD IN FOOD

New regulations[5] have been introduced, and are now in force, which limit further the maximum levels of lead permitted in food that is offered for sale.

The lead levels achieved within the existing Regulations confirm that for most people food is the major source of lead.

We consider, therefore, that the Regulations, the actual levels achieved and the state of food technology should be kept under review, with the intention of reducing permitted levels wherever and whenever possible.

A 4. SUMMARY AND CONCLUSIONS

(i) In the general population of the United Kingdom the major source of lead intake is from food. Although present levels of dietary lead present no proven toxic hazard, it is clear that the margin between the combined exposure levels which may occur from all sources and those which some investigators consider to be toxic is relatively narrow. Therefore, we feel it would be prudent to make every effort to ensure the widest possible margin of safety.

(ii) There is inadequate information on the overall effects of air lead including lead derived from industry and vehicle emissions on the body burden of lead.

(iii) There is insufficient information on the lead intakes from the diet of infants, pregnant women and young children and inadequate guidance on the tolerable levels of intake by these groups.

(iv) More information is needed on the proportional influences of the different pathways by which lead enters man, and coupled to this there is a need for research into the availability to man of lead in different food species and in drinking water.

Accordingly, we recommend that:

(v) Monitoring of food as consumed for lead should continue, with priority for particular foods of special concern — eg canned foods and foods cooked in the home.

(vi) Dietary studies should concentrate upon people at special risk due to high exposure or increased sensitivity, such as children both pre-and post-natally.

(vii) Work is carried out on the influences of the pathways by which lead reaches man and contributes to the body burden.

(viii) Work is carried out on factors (including general dietary factors) affecting the absorption of lead derived from food.

(ix) Carefully designed longitudinal studies with proper quality assurance should be carried out in population groups including children to investigate the effects on health of major changes in environmental exposure to lead.

TOXICOLOGY OF LEAD

B 1. ABSORPTION OF LEAD

For non-occupationally exposed populations the significant routes of absorption are the gastro-intestinal tract and the lungs. For humans absorption through the skin does not appear to be significant except in the case of fat soluble compounds, especially the alkyl leads.

Absorption and Availability via the Intestinal Tract

The Lawther Report[1] concluded that in adults an average of 10% of dietary lead was available for absorption, but that in children a higher rate (40%) should be assumed. Recent work[6] in USA confirms this higher rate in children. Some dietary studies have demonstrated a negative balance for lead, although such studies in both adults and children have been of short duration. There have been suggestions that the rates of absorption of lead may vary with the types of food; eg much of the lead which accumulates in kidneys is reported to be protein-bound and insoluble[7]. Chamberlain[8] has very recently reported a study on 6 volunteers who ingested liver and kidney containing Pb 203 in whom the mean absorption was 2.83% (±1.51). The rate of absorption of lead from the gastro-intestinal tract has been found to vary with the composition of the diet. Milk enhances the absorption of lead as well as of calcium, this effect being strongly dependent on its content of lactose. Dietary factors known to influence lead absorption also include the levels of other minerals, particularly calcium, phosphorus and magnesium, the levels of Vitamin D and phytate, the proportions of carbohydrate, fat and protein, and alcohol. The mechanisms by which these factors influence lead absorption are complex and in many cases poorly understood.

B 2. EXCRETION OF LEAD

The principal excretory route for ingested lead is faecal, but much of this represents unabsorbed lead. Levels of urinary excretion of lead tend to follow levels of absorption but there is no precise relationship, and the factors affecting excretion are poorly understood.

B 3. TOXICITY OF LEAD

a) Acute Toxicity

In adults, acute toxicity has occurred from the ingestion of 5-10 mg of lead daily for about one month, but the long term addition of 3 mg of lead (as the nitrate) to the normal dietary intake resulted in no overt toxicity, although free erythrocyte proto-porphyrin (FEP) levels were raised.[9] The initial results of lead toxicity (fatigue, anaemia, gastro-intestinal disturbance) may be followed by effects on the central nervous system (CNS). In children, the CNS effects may occur without premonitory symptoms or signs referable to other systems.

b) **Chronic Toxicity**

Overt clinical chronic toxicity (as shown by lethargy, anaemia, gastro-itestinal symptoms, progressing to effects on the peripheral and central nervous systems, and in longstanding cases renal impairment) is generally related to a blood lead concentration (PbB) of 80 μg/100 ml or more. Blood lead levels are considered to reflect recent exposure to lead (perhaps 6 weeks' duration) and the Lawther Report[1] found no convincing evidence of harm at levels below 35 μg/100 ml. Recognisable metabolic effects of lead can be detected at blood lead levels which are not known to be toxic. For example, a decreased activity ofδ-aminolaevulinic acid dehydratease (ALAD) which may be detected from levels of 5-10 μg/100 ml PbB, but is not thought to be harmful below 20 μg/100 ml; an increase in FEP, which may begin at 20-30 μg/100 ml PbB; and an increase in urinary ALA excretion. The significance for health of such reduced enzyme activity is debated; there is a possibility that substrate accumulation could be toxic. It has been estimated that in adults a daily increment of 100 μg of lead may increase the PbB by 1-7 μg/100 ml, depending on whether the baseline is 30 or 18 μg/100 ml. The response may be curvilinear. It has been calculated that ingestion of 2.3 or 3.3 mg/day of lead by an adult would result in a PbB of 80 μg/100 ml after 4 years or 8 months respectively. In young children, 1-2 mg/day may cause toxicity in 5 or 6 months. Ingestion of flakes of leaded paint is the most common cause of poisoning in children, the clinical pattern being one of acute-on-chronic toxicity.

c) **Carcinogenicity**

The Committee was aware of the experimental and epidemiological data relevant to the assessment of metallic lead and its salts, and of organic lead compounds for carcinogenicity — as reviewed by IARC, 1980. At exposure levels which exceed those that are lethal for man, rats and mice have been observed to develop renal tumours in response to certain inorganic lead salts. The practical significance of these observations is dubious, and there is no clear epidemiological evidence of excess cancer risk amongst lead workers. It was therefore agreed that any carcinogenic risk from lead would be very small and that any concern about it would be adequately taken into account by the Committee's conclusion that every effort should be made to ensure the widest possible margin of safety in exposure to lead.

d) **Appraisal of the Toxic Effects of Lead**

Our concern is with long-term effects of lead ingestion. This question can be considered from two standpoints — weekly intakes or blood levels of lead.

The FACC, in its Review of Lead in Food Regulations, 1961 (HMSO, 1975: FAC/REP/21) provided an estimate of lead intake from food and beverages of 1.2 mg/week for the average adult consumer. The recent report of a Department of Health and Social Security Working Party on Lead in the Environment[1] quotes more recent total diet studies commissioned by MAFF which give an average weekly intake of the order of 0.8 mg for an adult. Allowing for differences in analytical technique there has probably been no significant change in weekly intake. These values are well within the provisional tolerable weekly intake of 3 mg, for an adult, suggested by the FAO/WHO Expert Committee on Food Additives (WHO Tech.Rep.Ser.No 505, 1972) and would appear to indicate that lead levels in food, including canned food, do not constitute a problem.

However, the Council of the European Communities adopted a Directive (77/312/EEC) that member states should assess the exposure of the population to lead, outside the working environment, based on the measurement of blood levels over a four year period. The acceptable upper level (to be exceeded by only 2% of the population studied) is 35 µg/dl. This level was chosen because of its association with a significant increase in urinary excretion of ALA which can be interpreted as a sub-clinical effect on health. The survey carried out in the United Kingdom in 1979/80[10] showed that some children, subject to additional exposure in their domestic environment, had blood levels above 35 µg/dl. There is continuing concern about the possible neuropsychological effects of low exposure to lead in children[11], but no firm evidence on which to establish a safe level for blood lead concentration. In such a situation it can only be considered prudent to adopt measures to provide as wide a margin of safety as possible. While it cannot be suggested that the raised blood lead levels found in the survey resulted from ingestion of food containing undue amounts of lead, it must be borne in mind that for most of the population food constitutes the major source of exposure to lead.

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REPORT OF THE FOOD ADDITIVES AND CONTAMINANTS COMMITTEE

1. After consideration of the report "Survey of Lead in Food. Second Supplementary Report" at the meeting in July 1982 the Committee endorses the conclusions of the Working Party and the recommendations of the COT. The Committee pays especial regard to the conclusion of the COT that it would be prudent to make every effort to ensure the widest possible margin of safety. In the light of this conclusion the Committee recommends that efforts to reduce the contamination of food by lead should continue. New Lead in Food Regulations came into operation in 1980 and the Committee has recently recommended reductions in the statutory limits for lead in canned food[1]. The Committee considers that a nationwide reduction in the lead content of other foods and statutory limits is dependent to a large extent on action to reduce lead pollution of soil, air and water.

2. The Committee recommends therefore that:

a) the lead content of canned foods and the National Average diet continue to be regularly monitored to provide information on the effect of Government action to reduce lead pollution;
b) the monitoring of foodstuffs and replicate diets be continued with particular attention being paid to lead intakes by critical groups, such as children and pregnant women;
c) the Working Party should give priority to its efforts to identify and eliminate sources of lead contamination whether they be localised or general.

REFERENCE

1. Food Additives and Contaminants Committee. Report on the Review of Metals in Canned Food. HMSO. (To be published.)

RESULTS OF ANALYSES

LIST OF TABLES

1. Results of UK Total Diet Study, 1975-81.
2. Lead in individual food items of the national diet — Government data.
3. Lead in shellfish landed in England 1976-80.
4. Lead in shellfish landed in Wales 1976-80.
5. Lead in shellfish landed in Scottish waters 1976-79.
6. Lead in fruit and vegetables grown at Shipham.
7. Lead in foodstuffs produced near a disused smelter, Swansea.
8. Lead in vegetables and soft fruit grown near a metal refining plant.
9. Lead in crops grown in market gardens.
10. Analysis of fresh fruit and vegetables for lead content. 'Background' levels.
11. Early data on the lead content of foods.

All the results for analyses in these tables are reported in the form of mg/kg fresh weight except where otherwise indicated.

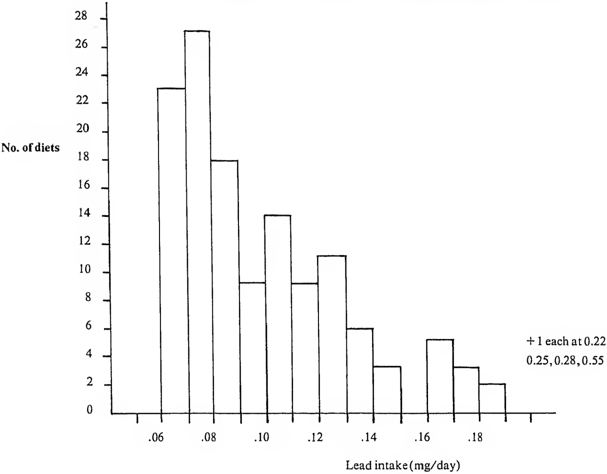
LIST OF FIGURES

1. Total Diet Study distribution of lead intakes 1975-81.
2. Lead in outer leaves of Brussels sprouts grown in the vicinity of a smelter.

APPENDIX III

SUMMARY OF LEAD INTAKES DERIVED FROM THE TOTAL DIET STUDY

Figure 1. Distribution of lead intakes[a] (1975-81)



+ 1 each at 0.22 0.25, 0.28, 0.55

a. The method of calculation imposes a minimum value on lead intake of 0.06 mg/day.

Intake summary — Individual years 1975-1981

Year	1975	1976	1977	1978
Number of diet samples	21	25	25	20
Mean intake (mg/day)	0.12	0.11	0.10	0.11
Median intake (mg/day)	0.09	0.10	0.10	0.10

Year	1979	1980	1981
Number of diet samples	19	16	8
Mean intake (mg/day)	0.09	0.12	0.08
Median intake (mg/day)	0.08	0.08	0.07

Intake summary — All years 1975-1981

Number of diet samples	134
Mean intake (mg/day)	0.10
Median intake (mg/day)	0.09
1st quartile intake (mg/day)	0.08
3rd quartile intake (mg/day)	0.12
Minimum intake (mg/day)	0.06

TABLE 1 Results of UK Total Diet Study
Lead Concentrations in Total Diet Samples and Daily Intake of Lead 1975-81 (a)

Food Group	Consumption (kg/day)	Range (mg/kg)	Mean Value (mg/kg)	Daily Intake (mg)
LEAD 1975 (First three quarters) (13 samples)				
1. Cereals	0.24	<0.05-0.25	<0.07	0.017
2. Meat and Fish	0.19	<0.05-0.35	<0.12	0.023
3. Fats	0.08	<0.05	<0.05	0.004
4. Fruit and preserves	0.19	<0.05-0.25	<0.09	0.017
5. Root Vegetables	0.22	<0.05-1.0	<0.16	0.035
6. Green Vegetables	0.13	<0.05-0.20	<0.10	0.013
7. Milk	0.40	<0.02-0.02	<0.02	0.008
Total	1.47			0.12 (c)
8. Fish		<0.05-0.25	<0.10	
LEAD 1975 (Fourth quarter) (8 samples)				
1. Cereals	0.23	<0.05-0.05	<0.05	0.012
2. Meat	0.15	<0.05-0.15	<0.08	0.012
3. Fish	0.02	0.05-0.20	0.09	0.002
4. Fats	0.08	<0.05-0.15	<0.06	0.005
5. Fruit and preserves	0.17	<0.05-0.15	<0.09	0.015
6. Root Vegetables	0.18	<0.05-0.20	<0.08	0.014
7. Other Vegetables	0.11	<0.05-0.70	<0.18	0.020
8. Beverages	0.12	<0.02-0.10	<0.04	0.024 (b)
9. Milk	0.40	<0.02	<0.02	0.008
Total	1.46			0.11 (c)
LEAD 1976 (25 samples)				
1. Cereals	0.23	<0.050-0.200	<0.068	0.016
2. Meat	0.15	<0.050-0.150	<0.088	0.013
3. Fish	0.02	<0.050-0.800	<0.126	0.003
4. Fats	0.08	<0.050-0.700	<0.100	0.008
5. Fruit and sugars	0.17	<0.050-0.200	<0.084	0.014
6. Root Vegetables	0.18	<0.050-0.300	<0.066	0.012
7. Green Vegetables	0.11	<0.050-0.800	<0.138	0.015
8. Beverages	0.12	<0.020-0.080	<0.026	0.016 (b)
9. Milk	0.40	<0.020-0.020	<0.020	0.008
Total	1.46			0.11 (c)
LEAD 1977 (25 samples)				
1. Cereals	0.23	<0.050-0.150	<0.064	0.015
2. Meat	0.15	<0.050-0.200	<0.092	0.014
3. Fish	0.02	<0.050-0.300	<0.114	0.002
4. Fats	0.08	<0.050-0.150	<0.062	0.005
5. Fruit and sugars	0.17	<0.020-0.250	<0.108	0.018
6. Root Vegetables	0.18	<0.050-0.250	<0.068	0.012
7. Green Vegetables	0.11	<0.050-0.250	<0.090	0.010
8. Beverages	0.12	<0.010-0.080	<0.023	0.014 (b)
9. Milk	0.40	<0.020-0.020	<0.020	0.008
Total	1.46			0.10 (c)

Table 1 (contd)

Food Group	Consumption (kg/day)	Range (mg/kg)	Mean Value (mg/kg)	Daily Intake (mg)
LEAD 1978 (20 samples)				
1. Cereals	0.23	<0.050-0.400	<0.093	0.021
2. Meat	0.15	<0.050-0.100	<0.070	0.011
3. Fish	0.02	0.050-0.700	0.148	0.003
4. Fats	0.08	<0.050-0.200	<0.065	0.005
5. Fruit and sugars	0.17	<0.050-0.350	<0.095	0.016
6. Root Vegetables	0.18	<0.050-0.100	<0.053	0.010
7. Green Vegetables	0.11	<0.050-0.500	<0.125	0.014
8. Beverages	0.12	<0.010-0.100	<0.029	0.017 (b)
9. Milk	0.40	<0.020-0.020	<0.020	0.008
Total	1.46			0.11 (c)
LEAD 1979 (19 samples)				
1. Cereals	0.23	<0.050-0.250	<0.074	0.017
2. Meat	0.15	<0.050-0.500	<0.095	0.014
3. Fish	0.02	<0.050-1.000	<0.153	0.003
4. Fats	0.08	<0.050-0.150	<0.055	0.004
5. Fruit and sugars	0.17	<0.050-0.300	<0.092	0.016
6. Root Vegetables	0.18	<0.050-0.200	<0.060	0.011
7. Green Vegetables	0.11	<0.050-0.500	<0.105	0.012
8. Beverages	0.12	<0.010-0.020	<0.015	0.009 (b)
9. Milk	0.40	<0.020-0.020	<0.020	0.008
Total	1.46			0.09 (c)
LEAD 1980 (16 samples)				
1. Cereals	0.23	<0.050-0.150	<0.072	0.017
2. Meat	0.15	<0.050-3.300	<0.272	0.041
3. Fish	0.02	<0.050-0.500	<0.122	0.002
4. Fats	0.08	<0.050-0.100	<0.056	0.004
5. Fruit and sugars	0.17	<0.050-0.200	<0.081	0.014
6. Root Vegetables	0.18	<0.050-0.200	<0.075	0.014
7. Green Vegetables	0.11	<0.050-0.400	<0.094	0.010
8. Beverages	0.12	<0.010-0.060	<0.023	0.014 (b)
9. Milk	0.40	<0.020-0.020	<0.020	0.008
Total	1.46			0.12 (c)
LEAD 1981 (8 samples)				
1. Cereals	0.23	<0.050-0.050	<0.050	0.012
2. Meat	0.15	<0.050-0.200	<0.081	0.012
3. Fish	0.02	0.050-0.150	0.094	0.002
4. Fats	0.08	<0.050-0.100	<0.063	0.005
5. Fruit and sugars	0.17	<0.050-0.100	<0.063	0.011
6. Root Vegetables	0.18	<0.050-0.100	<0.056	0.010
7. Green Vegetables	0.11	0.050-0.400	0.119	0.013
8. Beverages	0.12	<0.010-0.030	<0.013	0.008 (b)
9. Milk	0.40	<0.020-0.020	<0.020	0.008
Total	1.46			0.08 (c)

Table 1 (contd)

Food Group	Consumption (kg/day)	Range (mg/kg)	Mean Value (mg/kg)	Daily Intake (mg)
REVISED STUDY				
LEAD 1981 (10 samples)				
1. Bread and cereals	0.240	<0.050-0.050	<0.050	0.012
2. Meat and poultry	0.058	<0.050-0.050	<0.050	0.003
3. Offal	0.003	<0.050-0.500	<0.130	0.000
4. Meat Products	0.077	<0.050-0.050	<0.050	0.004
5. Fish	0.015	0.050-0.150	0.080	0.001
6. Oils	0.090	<0.050-0.050	<0.050	0.005
7. Sugars and preserves	0.095	<0.050-0.100	<0.055	0.005
8. Green Vegetables	0.046	<0.050-0.150	<0.065	0.003
9. Potatoes	0.159	<0.050-0.050	<0.050	0.008
10. Other Vegetables	0.068	<0.050-0.050	<0.050	0.003
11. Canned Vegetables	0.043	0.050-0.200	0.135	0.006
12. Fruit	0.060	<0.050-0.050	<0.050	0.003
13. Fruit products	0.024	0.050-0.250	0.155	0.004
14. Beverages	0.118	<0.010-0.040	<0.014	0.011 (b)
15. Milk	0.360	<0.020-0.020	<0.020	0.007
Total	1.456			0.08 (c)

(a) Analysis carried out by the Laboratory of the Government Chemist.

(b) Calculated assuming a 5-7 fold dilution prior to analysis. See paragraph 9.

(c) Totals rounded to the nearest 0.01 mg.

APPENDIX III

TABLE 2 — Lead in Individual Foodstuffs (a)

Food	No Samples	Mean (mg/kg)	Range (mg/kg)
MEAT AND FATS			
Bovine liver	4	0.1	0.05-0.18
Bovine kidney	7	<0.12	<0.05-0.45
Lamb — liver	4	0.30	0.05-0.91
— kidney	4	0.07	0.04-0.12
Pig — liver	4	0.06	0.02-0.10
— kidney	4	0.06	0.03-0.11
Cream — canned	2	<0.05	<0.05-0.05
— bottled	2	0.02	0.01-0.02
Cooking Oil	5	<0.01	
Eggs	5	<0.01	<0.01-0.01
Cheese	5	0.03	0.02-0.05
Butter	5	0.03	0.01-0.05
Margarine	3	<0.01	<0.01-0.01
Lard	2	0.02	0.01-0.02
FROZEN FOODS			
Broccoli	3	<0.01	
Brussels Sprouts	3	<0.01	
Broad Beans	3	<0.01	<0.01-0.01
Sweetcorn	3	<0.01	
Fish Fingers	3	0.02	
Spinach	3	0.17	0.04-0.38
BEVERAGES			
Fruit juices — imported canned (used for squash etc)	4	0.06	0.02-0.12
Fruit juices and syrups — bottled	11	<0.09	<0.01-0.18
Fruit juices — canned - plain	29	<0.09	<0.01-0.38
- lacquered	14	<1.16	<0.01-3.6
Concentrates and squashes — bottled	5	<0.09	<0.01-0.26
Concentrated frozen juices — canned	5	1.04	0.57-1.72
Mineral waters — bottled	16	<0.02	<0.01-0.12
Soft drinks — bottled, carbonated	2	<0.01	
— canned	5	<0.005	<0.005-0.005
Beers — bottled	3	<0.01	<0.01-0.01
— canned	4	0.016	0.01-0.035
Stout	1	<0.01	
Cider	2	<0.01	<0.01-0.01
Wines	5	0.07	0.05-0.12
Spirits	5	<0.01	<0.01-0.01
Tea — leaves	7	<0.17	<0.1-0.5
— dust	7	2.44	0.5-9.0
Tea bags — leaves	7	<0.26	<0.1-1.25
— dust	7	0.99	0.3-2.0
Tea, instant	2	0.35	0.22-0.48
instant lemon	2	<0.05	<0.05-0.05
Coffee, beans	3	0.25	0.21-0.27
instant granules	9	0.35	0.08-1.34
instant powder	8	<0.07	<0.05-0.25
Coffee essence	1	0.09	
Cocoa powder	1	<0.02	
Drinking chocolate	1	0.05	

Table 2 (contd)

Food	No Samples	Mean (mg/kg)	Range (mg/kg)
CEREALS, DRIED AND CONCENTRATED FOODS			
Bread, white	10	<0.05	<0.05-0.05
Bread, brown, wholemeal	10	<0.07	<0.05-0.20
Edible gelatine	6	0.16	0.05-0.35
Flour, plain	5	<0.05	<0.05-0.05
self-raising	5	<0.05	<0.05-0.05
wholemeal	5	<0.08	<0.05-0.2
Evaporated and condensed milks	5	<0.1	<0.05-0.25
Milk, dried	5	<0.08	<0.05-0.15
Gravy mix	5	<0.09	<0.05-0.2
Sugar, granulated	3	<0.03	
castor	1	<0.03	
brown	4	<0.04	<0.03-0.08
icing	2	<0.03	
Wheat, 1877-1970	14	0.12	0.05-0.20
1975 (UK)	23	<0.08	<0.05-0.55
Wheat, gluten	2	0.17	0.14-0.20
germ	1	<0.03	
Jellies	5	0.05	
Stock cubes	8	<0.22	<0.05-0.40
Salt (excl chemical reagent)	11	<0.02	<0.02-0.02
Soup, dried	3	0.83	0.55-1.08
Crab pastes	5	<0.06	<0.05-0.1
Lobster spreads and pâtés	5	<0.06	<0.05-0.1
Fish pastes	10	<0.23	<0.05-1.4
Fish spreads and pâtés	10	<0.1	<0.05-0.35
Chutneys	2	0.29	0.17-0.40
OTHER FOOD			
Baby foods, cereal and dried	15	<0.07	<0.05-0.20
Baby foods, in jars	9	<0.05	<0.05-0.05
canned	10	<0.07	<0.05-0.15
Baby foods with offal, in jars	5	<0.02	<0.01-0.03
canned	5	0.03	0.02-0.05
Sweets and chocolate	10	<0.05	<0.05-0.05
CANNED FRUIT			
Apples — W	2	0.43	0.40-0.45
Apricots — F	2	0.28	0.25-0.31
— J	2	<0.05	<0.01-0.09
— W	1	0.21	
Blackberries — W	2	0.38	0.25-0.50
Blackcurrants — W	1	0.90	
Cherries, black	2	0.16	0.13-0.18
red	1	0.10	
Figs — W	1	0.04	
Grapefruit — F	2	0.85	0.72-0.98
— J	2	0.21	0.18-0.24
Guava — W	1	0.43	
Mandarin oranges — F	2	0.75	0.22-1.28
— J	2	0.13	0.10-0.16
Paw Paw — W	1	0.52	
Peaches — F	2	0.79	0.44-1.13
— J	2	0.13	0.12-0.13
Pears — F	1	0.73	
— J	1	0.15	

F — Fruit J — Juice W — Whole

Table 2 (contd)

Food	No Samples	Mean (mg/kg)	Range (mg/kg)
Pineapple — F	2	0.29	0.21-0.37
— J	2	0.12	
Plums — F	3	0.34	0.22-0.43
— J	3	0.09	0.03-0.15
Raspberries — W	2	0.64	0.38-0.89
Rhubarb — F	1	0.32	
— J	1	0.16	
Strawberries — W	1	0.27	
Gooseberries — W	1	0.21	
Redcurrants — W	1	0.30	
CANNED VEGETABLES			
Asparagus	1	<0.03	
Beans, Baked	4	0.45	0.05-1.20
Broad	1	0.03	
Green	1	0.44	
Haricot	1	0.09	
Carrots	3	0.65	0.15-1.4
Celery hearts	1	1.23	
Mushrooms	1	<0.03	
Mixed vegetables	1	0.17	
Processed peas	1	0.18	
Petit pois	1	0.40	
Sweet corn	1	0.20	
Tomatoes, 'plum'	1	1.18	
Spinach	5	0.5	0.25-0.9
FRESH VEGETABLES			
Mushrooms	24	<0.06	<0.05-0.15
CANNED FISH			
Sardines/Oil	30	<0.74	<0.11-3.0
Sardines/Tomato Sauce	15	1.06	0.5-2.5
Anchovies/Oil	31	<1.10	<0.1-5.6
Brisling/Oil	5	<0.1	
Brisling/Tomato Sauce	5	<0.1	
Sild/Oil	5	<0.1	
Sild/Tomato Sauce	5	<0.1	

F — Fruit J — Juice W — Whole

(a) Results provided by the Laboratory of the Government Chemist and Food Science Laboratory.

TABLE 3 Lead in Shellfish -England - 1976-80 (a) (mg/kg fresh weight)

Species	No Individuals	No Analyses	Mean	Range
Crab (claw)	215	201	<0.2	<0.2-0.4
(body)	218	204	<0.2	<0.2-0.5
Lobster (claw)	114	104	<0.2	<0.2-0.5
(body)	113	103	<0.2	<0.2-0.5
(tail)	115	115	<0.2	<0.2-1.3
Cockle	551	11	<0.2	<0.2-0.8
Crawfish (body)	5	5	<0.2	
(tail)	5	5	<0.2	
Dublin Bay prawn (tail)	75	3	<0.8	<0.2-1.5
Mussel	4385+	97	<1.8	<0.2-12
Oyster	188	25	<0.4	<0.2-3.0
Prawn	108	4	<0.3	<0.2-0.6
Queens (muscle)	134	8	<1.7	<0.2-3.6
(gonad)	114	6	<0.8	<0.2-2.1
Scallop (muscle)	218	15	<0.4	<0.2-0.7
(gonad)	218	15	<0.5	<0.2-0.9
Shrimp, brown(b)	968+	35	<1.5	<0.2-9.0
Shrimp, pink(b)	377	20	<0.3	<0.2-1.4
Whelk	71	5	<0.2	<0.2-0.3
Winkle	842	27	<0.6	<0.2-1.4

(a) Results of a survey by the MAFF Fisheries Laboratory, Burnham-on-Crouch, including samples from the 1977, 1978 "Mussel watch" Survey, most of which were not from commercially exploited stocks.

(b) Shrimp analysed whole. Lead in edible part is likely to be lower.

TABLE 4 Lead in Shellfish - Wales - 1976-80 (a) (mg/kg fresh weight)

Species	No Individuals	No Analyses	Mean	Range
Crab (body)	10	10	<0.2	<0.2-0.3
(claw)	10	10	<0.2	<0.2-0.3
(unspecified)	4	4	<0.2	<0.2-0.2
Cockle	124	4	<0.3	<0.2-0.5
Lobster (body)	17	17	<0.2	<0.2-0.3
(claw)	17	17	<0.2	<0.2-0.3
(tail)	17	17	<0.2	<0.2-0.3
Mussel	1290	29	<3.3	<0.2-35
Oyster	327	2	<0.2-0.3	
Prawn (head)	4	1	<0.2	
(tail)	4	1	<0.2	
Scallop (muscle)	16	1	<0.2	
(gonad)	16	1	<0.2	
Shrimp, brown(b)	120	3	1.0	0.2-1.5
whole	158	1	<0.2	
peeled	158	1	<0.2	

(a) Results of a survey by the MAFF Fisheries Laboratory, Burnham-on-Crouch, including samples from the 1977, 1978 "Mussel watch" Survey, most of which were not from commercially exploited stocks. Includes the southern shore of the Bristol Channel and Severn Estuary east of Hartland Point.

(b) Shrimp analysed whole. Lead in edible part is likely to be lower.

TABLE 5 Lead in Shellfish from Scottish Waters 1976-79. (a) (mg/kg fresh weight)

Species	No Individuals	No Analyses	Mean	Range
Crab (claw)	29	29	<0.1	<0.1-0.4
(body)	28	28	<0.1	<0.1-0.74
Processed crab (white)		6		<0.1-<1.6
(brown)		6		<0.1-<1.0
Cockle		2	2.7	2.0-3.4
Lobster (claw)	9	9	<0.1	<0.1
(tail)	9	9	<0.1	<0.1-0.4
Mussel	3100	126	<0.9	<0.2-6.4
Dublin Bay prawn (tail)	71	17	<0.1	<0.1-0.1
Winkle (without shell)	150	2	<0.1	
Queen (muscle)	8	8	0.95	0.2-2.4
Razor fish		42		<0.2-<2.0
Scallop (muscle)	33	33	<0.25	<0.1-1.5
(gonad)	26	26	<0.22	<0.1-2.5
Shrimp, brown		2		<1.2-1.6

(a) Results of a survey by the DAFS Marine Laboratory, Aberdeen including samples from the 1977 "Mussel watch" survey, most of which were not from commercially exploited stocks.

TABLE 6 Lead in Fruit and Vegetables Grown at Shipham (a) (mg/kg fresh weight)

Fruit/Vegetable	WINTER CROPS			SUMMER CROPS			
	No Samples	Mean	Range	No Samples	Mean	Range	
Artichoke	5	2.17	0.29-8.90				
Cabbage	14	1.47	0.45-4.47	59	0.24	0.02-0.77	
Carrot	16	1.29	0.21-3.82	55	0.26	0.05-1.2	
Kale	7	2.12	1.34-3.38	9	0.25	0.02-0.36	
Leek	41	1.38	0.15-4.27	8	0.14	0.07-0.28	
Parsnip	27	1.64	0.34-5.95	12	0.24	0.12-0.54	
Spinach	8	2.79	0.12-7.50	12	0.29	0.02-0.76	
Sprouts	30	1.07	0.12-3.60	11	0.09	0.02-0.19	
Apples				7	0.08	0.02-0.21	
Beetroot				29	0.18	0.06-0.69	
Blackcurrants				12	0.14	0.04-0.28	
Broad Bean				25	0.23	0.01-1.65	
Courgettes				13	0.17	0.02-0.94	Note: For some crops only a limited number of samples were available and the results should therefore be treated with caution (some of these samples came from uncontaminated parts of the village)
French Bean				11	0.11	0.04-0.13	
Gooseberries				15	0.08	0.01-0.74	
Herbs				64	1.45	0.88-6.0	
Lettuce				75	0.32	0.02-2.16	
Marrow				6	0.07	0.02-0.13	
Onion				23	0.17	0.03-0.54	
Peas				24	0.21	0.01-1.28	
Plums				8	0.08	0.03-0.13	
Potatoes				62	0.14	0.02-0.39	
Raspberries				15	0.06	0.01-0.19	
Rhubarb				71	0.33	0.04-1.07	
Runner Bean				59	0.06	0.01-0.25	
Shallots				12	0.18	0.03-0.29	
Spring Onion				8	0.15	0.07-0.46	
Tomato				11	0.04	0.01-0.07	
Turnip				8	0.20	0.05-0.46	

(a) Analyses carried out by Somerset County Analyst's Department, and MAFF Food Science Laboratory.

TABLE 7 Lead in Foodstuffs Produced Near a Disused Smelter, Swansea (mg/kg fresh weight)

	No Samples	Mean	Range
Beetroot	18	0.14	0.03-0.29
Lettuce	22	0.26	0.09-0.49
Milk			
July 1972	39	0.016	0.007-0.076
March 1973	33	0.011	0.006-0.025

Acknowledgement: Borough of Afan

TABLE 8 Lead in Vegetables and Soft Fruit Grown Near a Metal Refining Plant (mg/kg fresh weight)

Sample	Year of Sampling	Nature of Sample	No Samples	Range	Mean
Brussels Sprouts	1974	Outside leaves (Raw)	21	0.17-8.90	2.28
		Inside leaves (Raw)	21	0.02-0.67	0.12
	1975	Outside leaves (Raw)	11	0.5-13.0	3.61
		Inside leaves (Raw)	11	Nil-0.49	0.16
	1976	Outside leaves (Raw)	13	0.60-9.30	3.64
		Inside leaves (Raw)	13	0.02-0.33	0.13
	1977	Outside leaves (Raw)	11	0.80-9.84	3.67
		Inside leaves (Raw)	11	0.05-0.63	0.23
	1978	Outside leaves (Raw)	13	0.35-9.05	3.29
		Inside leaves (Raw)	13	0.06-1.51	0.41
	1979	Outside leaves (Raw)	14	0.46-6.88	2.85
		Inside leaves (Raw)	14	0.18-1.56	0.56
	1980	Outside leaves (Raw)	7	0.89-8.90	3.36
		Inside leaves (Raw)	7	0.11-0.68	0.3
Lettuce	1974	Outside leaves	7	0.5-7.3	3.93
		Inside leaves	7	0.1-1.8	0.96
	1975	Outside leaves	5	0.7-7.9	2.72
		Inside leaves	4	0.1-0.4	0.25
	1976	Outside leaves	5	2.3-10.2	7.76
		Inside leaves	5	0.14-3.70	0.90
	1977	Outside leaves	5	0.3-16.5	7.22
		Inside leaves	5	0.1-1.9	0.78
	1978	Outside leaves	8	1.2-7.3	2.64
		Inside leaves	8	0.3-1.0	0.54
	1979	Outside leaves	8	2.0-9.2	4.82
		Inside leaves	8	0.1-5.0	1.85
	1980	Outside leaves	5	2.5-8.5	5.16
		Inside leaves	5	0.2-1.5	0.8
Raspberries	1974	Unwashed	3	Nil-0.06	0.04
		Washed	3	Nil-0.06	0.04
	1975	Unwashed	3	0.30-0.49	0.39
		Washed	3	0.15-0.19	0.17

Table 8 (contd)

Sample	Year of Sampling	Nature of Sample	No Samples	Range	Mean
	1976	Unwashed	3	0.35-0.97	0.66
		Washed	3	0.15-0.80	0.42
	1980	Unwashed	3	0.06-0.13	0.09
		Washed	3	0.04-0.06	0.05

Acknowledgement

These results are included by courtesy of the Environmental Health Department, Beverley Borough Council.

TABLE 9 Lead in Vegetables Grown in Market Gardens (a) (mg/kg fresh weight)

Vegetable	No of samples	Mean	Range
Beetroot	5	0.04	0.02-0.07
Broad Bean	2	0.04	0.03-0.05
Broccoli	4	0.25	0.02-0.70
Cabbage	35	<0.05	<0.01-0.25
Carrot	2	0.08	
Cauliflower	5	<0.05	<0.01-0.12
Celeriac	1	0.05	
Celery	3	0.10	0.07-0.16
Chinese cabbage	3	0.09	0.03-0.17
Courgettes	2	0.02	0.01-0.02
Dwarf bean	1	0.06	
Kale	2	1.0	0.33-1.66
Leek	23	<0.08	<0.01-0.70
Lettuce	50	<0.09	<0.01-0.44
Marrow	4	0.03	0.01-0.03
Mint	2	0.97	0.04-1.90
Parsley	4	0.50	0.18-1.02
Parsnip	3	0.07	0.05-0.08
Potato	7	0.04	0.02-0.08
Radish	5	<0.12	<0.01-0.35
Spinach	11	0.39	0.10-0.78
Spinach beet	1	0.46	
Spring onion	15	0.06	0.02-0.15
Spring greens	10	0.21	0.05-0.57
Sweetcorn	7	0.03	0.02-0.04
Turnip	4	0.03	0.01-0.03

(a) Results of analyses carried out by the MAFF Food Science Laboratory.

TABLE 10 Analysis of Fresh Fruit and Vegetables for Lead Content (a) 'Background' Levels (mg/kg fresh weight)

Food Crop	No of samples	Mean	Range
Brussels sprouts	16	<0.05	<0.01-0.24
Cabbages	23	<0.08	<0.01-0.51
Carrots	8	<0.02	<0.01-0.04
Leeks	4	0.06	0.04-0.07
Mushrooms	6	0.06	0.03-0.13
Onions	11	<0.06	<0.01-0.38
Pears	17	<0.10	<0.01-0.23
Potatoes	19	<0.04	<0.01-0.14
Plums	5	0.11	0.06-0.16
Rhubarb	5	0.07	0.04-0.15
Swede	8	<0.02	<0.01-0.05
Tomato	10	0.06	0.01-0.14
Watercress	4	0.15	0.08-0.33

(a) Results submitted by the MAFF Agricultural Science Service Laboratory, Harpenden.

TABLE 11 Early Data on the Lead Content of Food

Food	Year	No of samples	Mean (mg/kg)	Range (mg/kg)	Comments
Corned beef (canned)	1941-42	98	5.4	0.5-30	Analysis of whole can contents. 29% of samples >5 mg/kg
Corned beef (canned)	1949	405	5.2	<2.0->20	Mean calculated from frequency distribution of data. 28% of samples >5 mg/kg
Corned beef (canned)	1951-54	78	6.3	0.6-45	Whole contents analysed. 12oz and 6lb can size. 33% of samples >5 mg/kg
Corned beef (canned)	1955-59	22	3.9	0.6-27	23% >5 mg/kg
Corned beef (canned)	1966	26	1.5	0.5-3.4	None >5 mg/kg
Miscellaneous canned meat	1930-49	38	1.2	0.2-8.0	One sample >2 mg/kg
Miscellaneous canned meat	1935-39	42	1.4	(0-2)-(6-10)	Mean calculated from frequency distribution 8% of samples >2 mg/kg
Miscellaneous canned meat	1940-48	1082	2.3	(0-2)->25	Mean calculated from frequency distribution 27% of samples >2 mg/kg
Tongue (canned)	1935-39	43	2.1	(0-2)-(3-5)	37% of samples >2 mg/kg
Tongue (canned)	1940-48	122	2.3	(0-2)->25	32% of samples >2 mg/kg
Stewed meat (canned)	1940-48	167	2.1	(0-2)-(16-20)	25% of samples >2 mg/kg
Sardines (canned)	1935-39	887	4.1	(0-2)-25	59% of samples >2 mg/kg
Sardines (canned)	1940-48	474	2.4	(0-2)-(21-25)	36% of samples >2 mg/kg
Pilchards (canned)	1940-48	402	1.8	(0-2)-(12-14)	23% of samples >2 mg/kg
Herrings (canned)	1942-49	3	6.3	4-8	
Miscellaneous canned fish and shellfish	1935-39	380	2.6	(0-2)-(6-10)	46% of samples >2 mg/kg
Miscellaneous canned fish and shellfish	1940-48	1070	2.0	(0-2)-(21-25)	28% of samples >2 mg/kg
Miscellaneous canned fish and shellfish	1952	40	1.9	<0.5-6.3	
Cider (bottled)	1940-49	44	0.36	0.1-0.8	
Cider (vat)	1940-41	43	0.34	0.1-0.4	
Beer	1922-26	64	1.1	(0-2)-(3-5)	It is not known whether the beer was bottled or draught
Beer	1927-39	129	1.8	(0-2)-(21-25)	It is not known whether the beer was bottled or draught
Beer	1932-48	387	1.1	(0-2)-(3-5)	It is not known whether the beer was bottled or draught
Draught beer	1938-42	53	0.47	0.1-1.4	
Draught beer	1941-50	57	0.39	0.1-3.0	

Table 11 (contd)

Food	Year	No of samples	Mean (mg/kg)	Range (mg/kg)	Comments
Draught beer (Country district)	1937-44	36	1.8	<0.2-13	Higher lead in country samples because of greater use of leaded dispensing systems
Draught beer (Town district)	1937-44	29	0.12	<0.2-(0.2-0.5)	
Ready-to-drink soft drinks	1949	1199	0.11	(0-0.2)-(0.51-1.0)	Not known whether canned or bottled. Mean is calculated from distribution of data. 25%>2 mg/kg.
Ready-to-drink soft drinks	1955	100	0.4	(0-0.2)->1.0	Not known whether canned or bottled. Mean is calculated from distribution of data 40%>0.2 mg/kg. Samples are from a possible high water-lead area.
Ready-to-drink soft drinks (canned)	1964	51	0.47	(0-0.2)-2.2	Mean estimated from distribution of data. 50%>0.2 mg/kg. Cans were lead soldered.
Ready-to-drink soft drinks (canned)	1968	16	0.06	0.01-0.3	19%>0.2 mg/kg. Cans were tin soldered by this time.
Wine (bottled)	1947-48	18	0.4	0.02-0.64	French wines
Wine (vat)	1946-47	18	0.17	0.01-1.0	French wines
Wine	1955	55	0.23	0.04-0.86	Australian wines, presumably in bottles, and includes red, white and fortified wines.
Tea leaves (lead lined chests)	1933-36	285	16.4	(0-15)->100	Mean estimated from distribution of data
Tea leaves (aluminium lined chests)	1933-36	141	16.5	(0-15)->100	Mean estimated from distribution of data
Tea leaves (lead lining and paper inner)	1933-36	118	17.9	(0-15)->100	Mean estimated from distribution of data
Tea leaves (aluminium lining and paper inner)	1933-36	23	9.5	(0-15)-(16-30)	Mean estimated from distribution of data
Tea leaves (unknown lining)	1933-36	335	20.1	(0-15)->100	Mean estimated from distribution of data
Tea leaves - Total of above samples	1933-36	902	17.8	(0-15)->100	Mean estimated from distribution of data
Tea leaves	1936-39	668	18.9	(0-10)->50	Mean estimated from distribution of data
Tea leaves	1935-39	62	9.0	(0-2)->25	Mean estimated from distribution of data
Tea leaves	1949	9	10.5	0.3-27.7	
Tea leaves	1950	7	1.3	0.9-1.7	Analysis of green tea leaf before drying
Miscellaneous canned vegetables	1935-39	103	1.4	(0-2)-(3-5)	13%>2 mg/kg
Miscellaneous canned vegetables	1940-48	227	1.2	(0-2)-(3-5)	7%>2 mg/kg
Canned peas	1952	7	1.3	0.4-3.7	1 sample>2 mg/kg
Canned soups	1952	30	0.8	<0.2-1.9	
Baked beans in tomato sauce (canned)	1940-48	56	1.5	(0-2)-4.7	18% >2 mg/kg
Baked beans in tomato sauce (canned)	1952	5	0.9	0.4-1.3	None >2 mg/kg

Table 11 (contd)

Food	Year	No of samples	Mean (mg/kg)	Range (mg/kg)	Comments
Curry powder	1935-39	15	1.7	(0-2)-(6-10)	None >10 mg/kg
Curry powder	1940-48	109	5.4	(0-2)->25	9% >10 mg/kg
Curry powder	1944-48	104	10.8	(0-2)-32	40% >10 mg/kg
Curry powder	1949	83	12.4	(0-2)-164	42% >10 mg/kg
Curry powder	1950-55	1455	6.3	<0.5-100	16% >10 mg/kg
Condensed milk (canned)	1935-39	419	1.0	(0-2)-(2-5)	2% >2 mg/kg
Condensed milk (canned)	1940-48	166	1.3	(0-2)-(2-5)	13% >2 mg/kg

TABLE 12 Species of Shellfish Sampled

Common Name	Generic Name
Molluscs	
Cockle	*Cardium edule*
Mussel	*Mytilus edulis*
Oyster	*Ostrea edulis*
Periwinkle or Winkle	*Littorina littorea*
Queen Scallop	*Clamys opercularis*
Razor Fish	*Solen marginatus*
Scallop	*Pecten maximus*
Whelk	*Buccinum undatum*
Crustaceans	
Brown Shrimp	*Crangon crangon*
Crab	*Cancer pagurus*
Crawfish	*Palinurus elephas*
Lobster	*Homarus vulgaris*
Dublin Bay Prawn	*Nephrops norvegicus*
Pink Shrimp	*Pandalus montagui*
Prawn	*Palaemon serratus*

APPENDIX V

TABLE 13 Results Submitted by Public Analysts

SHELLFISH, FRESH OR FROZEN

	No samples	Mean (mg/kg)	Range (mg/kg)
SHELLFISH FROM MORECAMBE BAY			
Cockles	15	1.07	0.31-1.88
Mussels	32	4.78	0.18-10.9
Shrimps	16	0.80	0.20-1.90
OTHER SHELLFISH (incl Humber Estuary & Bristol Channel)			
Clam	3	0.4	ND-0.8
Cockles	30	1.50	0.25-7.4
Crab	29	<0.55	<0.1-1.10
Mussels	32	<3.4	<0.5-9.0
Prawns	41	0.91	ND-7.6
Scampi	9	0.7	0.2-1.3
Shrimps	33	1.32	0.1-4.0
Whelks	59	0.92	0.1-6.6
Winkles	10	1.29	0.2-2.0
BOTTLED, CANNED & DRIED SHELLFISH			
Bottled			
Mussels	3	0.28	0.24-0.3
Prawns in brine	10	0.4	ND-0.7
Shrimp, potted	3	0.6	ND-0.9
Shrimp/Brine	3	<0.5	<0.5-0.5
Canned			
Crab	17	1.2	0.17-10
Langostinos (Norway Lobster)	14	<0.8	<0.5-1.2
Lobster	8	1.2	0.2-3.3
Mussels/vinegar	6	0.9	0.3-1.4
Oyster	6	<0.8	<0.5-1.2
Prawns	29	0.7	0.1-1.5
Shrimps	27	0.6	0.3-1.2
Dried			
Prawns	3	0.9	0.5-1.2
Shrimps	7	0.8	0.3-2.3
Other			
Crab, Dressed	13	0.6	0.1-2.6
Prawns (peeled, cooked)	10		<0.3-<0.5
SHELLFISH PRODUCTS			
Crab pastes and spreads (bottled)	4	0.25	0.1-0.3
Lobster pâté (canned and bottled)	3	0.4	0.2-0.6
FISH, FRESH OR FROZEN; FISH FROM MORECAMBE BAY			
Dab	8	0.50	0.11-1.5
Dace	5	0.38	0.15-0.70
Dover Sole	8	0.5	0.1-1.9
Flounder	12	0.33	0.1-1.29
Mackerel	6	0.42	0.13-0.70
Plaice	12	0.41	0.13-1.16
Salmon	5	0.3	0.15-0.50
Sea Trout	3	0.34	0.21-0.60
Skate	6	1.33	1.00-1.70
Sprats	6	0.39	0.22-0.89
Whitebait	3	0.39	0.32-0.52

Table 13 (contd)

	No samples	Mean (mg/kg)	Range (mg/kg)
OTHER FISH			
Cod/Codling (incl fillets)	11	0.41	ND-1.20
Coley	3	<0.11	<0.01-0.31
Dab/Dab Sole	5	0.14	0.02-0.3
Dace	5	0.83	0.17-3.40
Dogfish	3	0.21	0.13-0.3
Eel	6	0.51	0.3-1.2
Haddock	5	0.38	ND-0.80
Hake	5	<0.4	<0.01-0.7
Halibut	4	0.38	ND-0.60
Herring	9	1.42	ND-5.92
Lemon Sole	13	0.67	0.03-4.32
Ling	4	0.15	0.01-0.28
Mackerel	20	<0.55	<0.01-5.92
Octopus (incl squid)	6	<0.5	
Plaice	31	0.48	ND-4.88
Salmon	13	0.71	0.04-2.0
Skate	4	0.44	0.13-1.0
Whiting	15	0.43	ND-1.53
Witch sole	3	0.9	0.5-2.0
DRIED AND CANNED FISH			
Dried			
Dried fish (incl Bombay duck)	4	0.77	0.2-1.4
Squid	4	0.57	0.3-0.8
Canned			
Anchovies/Brine, oil	23	1.7	ND-3.3
Herring/Tomato sauce, horseradish, beer sauce, lemon sauce	11	<0.71	<0.1-2.0
Mackerel/Oil, tomato sauce	17	0.64	ND-1.95
Pilchards/brine, tomato sauce	152	0.84	ND-4.8
Salmon	17	0.73	0.09-1.6
Sardines/Oil, tomato sauce	52	<1.37	<0.1-4.9
Sild/Oil, tomato sauce	8	<0.6	<0.1-1.9
Sprats, smoked, in oil	3	1.4	0.3-3.6
Tuna/Tunny fish/oil, spaghetti sauce	128	<0.66	<0.1-3.1
Canned fish, unclassified	67	<1.4	<0.5-9.3
Other			
Cod roes	7	<0.47	<0.1-1.0
Lumpfish caviar	3		<0.5-<1.0
MEAT PRODUCTS			
FRESH/FROZEN MEAT			
Liver, ox	29	0.53	0.2-1.05
pig	117	0.86	0.02-8.0
lamb	50	<0.6	<0.2-4.1
chicken	13	2.25	0.7-15.7
Kidney, pig	15	0.5	0.1-1.3
lamb	16	0.54	0.12-1.3
CANNED MEAT PRODUCTS			
Burgers (Beef or ham)	8	0.71	0.2-1.9
Burgers and onions	3	0.3	0.2-0.3
Chicken	6	0.35	0.2-0.5
Corned beef	377	<0.73	<0.02-9.5
Curry dishes	10	0.66	0.17-0.9
Ham	33	<0.31	<0.02-1.5
Irish Stew	4	0.6	0.4-0.8
Luncheon meat (incl Spam)	21	<0.6	<0.2-3.3
Meat soup	67	0.36	0.05-0.4
Pâté	3	0.5	0.4-0.6

Table 13 (contd)

	No samples	Mean (mg/kg)	Range (mg/kg)
Pork	4	1.2	0.6-1.7
Stewed and minced beef steak	10	0.56	0.15-1.0
Tongue, ox	12	<0.5	<0.1-2.2
OTHER MEAT PRODUCTS			
Stew mixture (dried)	3	0.63	0.5-0.8
FRESH FRUIT			
Apples	51	<0.36	<0.005-0.9
Blackcurrants	3	0.6	0.3-1.2
Grapes	14	1.6* *(0.6 without 15)	0.06-15
Greengages and Plums	4	0.34	0.2-0.7
Loganberries	3	0.33	0.3-0.4
Pears	12	0.39	0.1-1.5
Raspberries	3	0.34	0.12-0.5
Strawberries	9	0.25	0.04-0.5
CANNED FRUIT			
Apples/syrup	6	0.4	0.2-0.5
Apricots	27	0.7	0.2-5.3
Breadfruit	6	<0.55	<0.5-0.7
Cherries	3	<0.6	<0.5-0.8
Figs	4	0.4	0.2-0.6
Fruit salad/cocktail	115	<0.42	<0.02-1.7
2 Fruits	3	0.5	0.3-0.7
Gooseberries	8	0.5	0.2-1.12
Grapefruit	63	0.47	0.1-1.57
Guava	4	0.6	0.4-0.9
Jackfruit	4	<0.35	0.29-<0.4
Loganberries	5	<0.6	<0.3-0.7
Lychees	11	0.5	0.29-0.9
Mandarin oranges	34	0.91	0.19-6.3
Mango/syrup	142	0.73	0.1-5.7
Peaches	79	<0.37	<0.02-1.4
Pears	25	<0.4	<0.1-1.3
Pineapple	26	<0.27	<0.02-1.7
Plums	9	0.4	0.2-0.8
Prunes	7	0.28	0.1-0.75
Raspberries	4	1.0	0.3-2.4
Rhubarb	72	<0.7	<0.02-2.1
Strawberries	7	0.41	0.12-1.1
FRUIT PRODUCTS			
Banana pulp	3	<0.6	
Fruit pulp	5	0.13	ND-0.25
Fruit pie fillings (canned)	62	0.42	0.05-1.5
Mango pulp	20	<0.4	<0.1-0.7
Mixed peel	4	0.33	ND-0.8
BEVERAGES			
Beer, ales and lager	123	<0.14	<0.1-0.40
Chocolate	3	0.30	0.2-0.5
Cocoa beans	7	<0.8	<0.6-1.0
Coffee beans	12	<0.6	
Coffee, instant	4	<0.6	<0.4-1.0
Dandelion coffee	4	0.5	0.36-0.8

Table 13 (contd)

	No samples	Mean (mg/kg)	Range (mg/kg)
BEVERAGES–*contd*			
Fruit juices			
Apple	8	0.16	0.08-0.38
Grapefruit	11	0.25	0.08-0.53
Lemon	8	0.6	0.05-2.6
Mango juice	3	<0.25	
Mango nectar	6	0.4	0.1-1.0
Orange	13	0.30	0.04-1.3
Passion fruit	6	<0.25	
Pineapple	18	<0.21	<0.1-0.5
Fruit juice, unspecified	222	0.26	0.05-0.5
Shandies	4	0.68	0.23-1.72
Soft drinks, ready-to-drink			
Grapefruit	28	0.24	0.08-0.7
Lemonade	3	<0.02	
Mango	3	<0.2	
Orange	36	<0.21	<0.02-1.8
Soft drinks, ready-to-drink, unspecified	23	0.13	0.02-0.5
Tea, infusion	5	0.17	0.1-0.4
instant	15	<1.07	<0.5-6.1
leaf (mainly Indian)	34	1.52	0.2-3.9
leaf	103	<5.0	<0.4-102
Teas, special	4	1.77	1.33-2.36
Wines (red and white)	10	<0.25	<0.1-0.3
SUGAR CONFECTIONERY AND NUTS			
Chewing and Bubble gum	30	0.12	0.04-0.2
Chocolate and chocolate confectionery	29	<0.29	<0.05-1.5
Confectionery from vending machines	24	<0.21	<0.05-0.9
Honey and honey spread	4	0.5	ND-0.7
Ice cream	36	0.2	ND-2.1
Ice lollies	19	<0.4	<0.1-2.4
Jams, various	17	0.1	ND-0.3
Jelly, Table	8	0.2	0.1-0.2
Lollipops	35	<0.13	<0.05-0.6
Marmalade	10	0.5	ND-1.3
Marzipan	8	0.1	ND-0.2
Milk chocolates, assorted (including imported)	7	0.6	0.4-1.0
Mincemeat	11	0.25	ND-0.8
Moulded sugar confectionery	65	0.17	0.02-0.74
Moulded chocolate confectionery	24	0.38	0.05-1.3
Peanut butter	5	0.1	ND-0.4
Sugar confectionery	8	<0.3	<0.01-1.6
BABY FOODS			
Baby foods, 1975/76			
Canned savoury	6	0.37	0.21-0.50
Canned dessert	5	0.22	0.16-0.36
Dried (incl rusks)	5	0.43	0.07-1.16
Unspecified	24	0.08	ND-0.2
Baby foods, 1976/80			
Canned savoury	62	0.15	0.01-0.7
Canned dessert	31	0.63	0.003-3.3
Unspecified	3	0.11	0.08-0.14
HERBS			
Herbs, unspecified	39	3.8	0.4-11.3
Sage, dried	3	7.3	0.87-13.1
Stuffing mix	34	1.3	0.13-2.06
Medicinal herbs	6	6.0	5.0-7.8

Table 13 (contd)

	No samples	Mean (mg/kg)	Range (mg/kg)
VEGETABLES, FRESH OR FROZEN			
Brussels sprouts	11	1.9	0.2-5.2
Lettuce	6	4.3	0.5-6.7
Peppers, red	3	0.37	0.26-0.44
Potatoes, fresh	17	0.16	0.03-0.4
Fresh vegetables (unclassified)	29	0.6	0.16-1.5
VEGETABLES, CANNED			
Asparagus	47	0.44	0.2-1.1
Bamboo shoots	3	<0.4	
Broad beans	6	<0.38	0.23-<0.5
Carrots	50	<0.25	<0.02-1.05
Corn	6	<0.5	<0.4-0.7
Green beans	25	0.36	0.05-1.0
Mixed vegetables	4	0.5	0.2-1.2
Mushrooms	5	0.4	0.2-0.5
Okra	4	0.5	0.4-0.7
Peas	66	<0.25	<0.02-1.9
Potatoes	46	<0.28	<0.02-0.8
Water chestnuts	3	0.31	0.22-0.46
VEGETABLES, OTHER			
Leeks, dried	3	<0.5	—
Onions, dried	21	0.9	0.3-2.7
Onions, pickled	3	1.11	0.77-1.37
Potato, dried	5	0.24	0.04-0.55
Vegetables, pickled and preserved	10	0.62	ND-1.5
Vegetables, pickled (bottled)	8	0.12	0.1-0.2
VEGETABLE PRODUCTS			
Baked beans	61	<0.36	<0.05-1.5
Carrot juice (canned)	5	<0.4	<0.4-0.4
Pease pudding (canned)	3	0.9	0.4-1.8
Stuffed vegetables (cabbage, aubergine)	3	0.53	0.3-0.9
Vegetable soup (canned)	29	0.54	0.05-2.4
TOMATO AND TOMATO PRODUCTS			
Tomatoes, fresh	18	0.5	0.1-1.3
Tomatoes, canned	224	<0.81	<0.02-11
Tomato pastes and purées	9	0.7	0.3-0.8
Tomato paste, canned	12	1.0	0.1-2.0
Tomato purée. condensed	9	3.6	1.4-6.0
Tomato soups, canned	4	<0.25	<0.1-0.4
Tomato juice, canned	15	0.32	0.1-0.54
CEREAL PRODUCTS			
Biscuits	6	0.2	ND-0.3
Cereals, Breakfast	9	0.5	Trace-0.9
Flour	15	0.3	0.1-0.8
Milk puddings	5	0.3	0.2-0.6
Pasta products (ravioli, bolognese, lasagne, canelloni)	76	0.42	0.05-1.6
Pudding/Pastry mixes	6	0.6	0.2-1.0
Rice (incl savoury rice)	6	0.3	0.13-0.5
Sponge puddings (canned)	9	0.28	0.1-0.8
OILS, FATS AND DAIRY PRODUCTS			
Coffee creamer	3		<0.1-<0.5
Condensed milk (canned)	13	0.41	0.02-0.7
Cream (canned)	30	<0.33	0.02-1.4
Custard (canned)	6	0.5	0.3-0.7

Table 13 (contd)

	No samples	Mean (mg/kg)	Range (mg/kg)
OILS, FATS AND DAIRY PRODUCTS–*contd*			
Eggs, brown and white	16	0.59	0.21-1.53
Evaporated milk	29	<0.42	<0.02-1.1
Lard	5	0.03	ND-0.1
PICKLES AND SPICES			
Chilli powder	3	1.3	0.02-2.0
Cinnamon powder	7	2.3	0.39-7.5
Curry paste (canned)	29	<1.5	<0.1-5.8
Curry powders	64	<2.7	<0.4-43.3
Ginger, ground	3	1.3	0.9-2.6
Mustard	4	0.4	0.1-0.6
Nutmeg, ground	3	<0.4	<0.2-0.7
Paprika	4	3.7	2.2-5.4
Pickling spices	3	2.6	0.59-5.9
Pickles and chutneys, various	201	1.1	0.04-24.4
Spices, various	40	2.7	0.15-10.5
SAUCES, DRESSINGS, MIXES etc			
Gravy mixes	14	0.54	0.2-1.4
Salad dressing	11	0.45	0.1-1.5
Sauces and ketchups	97	0.57	0.05-4.8
Sauce mixes	14	0.66	0.1-2.23
Soya sauce	7	<2.2	<0.1-11.3
Vinegars	11	0.03	ND-0.1
MISCELLANEOUS			
Baking powder	7	0.03	ND-0.1
Dried yeasts	4	1.5	0.5-3.2
Essences and flavourings:			
Almond essence	8	0.97	0.15-1.9
Cochineal essence	4	0.86	0.35-1.1
Lemon flavouring	12	<1.68	<0.01-3.7
Rum essence	3	1.28	0.30-3.2
Vanilla essence	6	2.16	0.19-10
Gelatin powder	4	<1.3	<0.1-3
Toast toppers (canned)	3	0.3	0.2-0.3

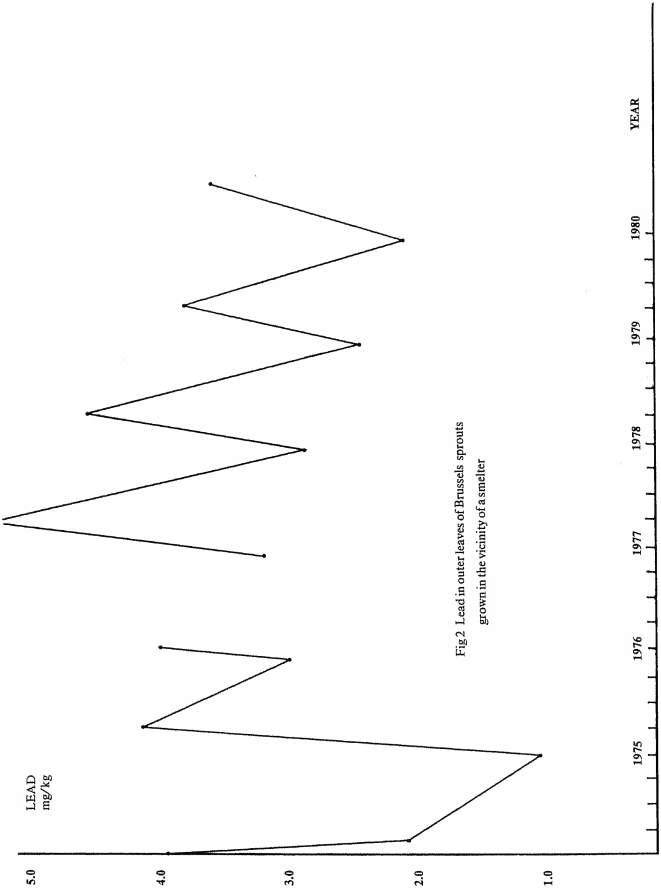


Fig 2 Lead in outer leaves of Brussels sprouts grown in the vicinity of a smelter

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